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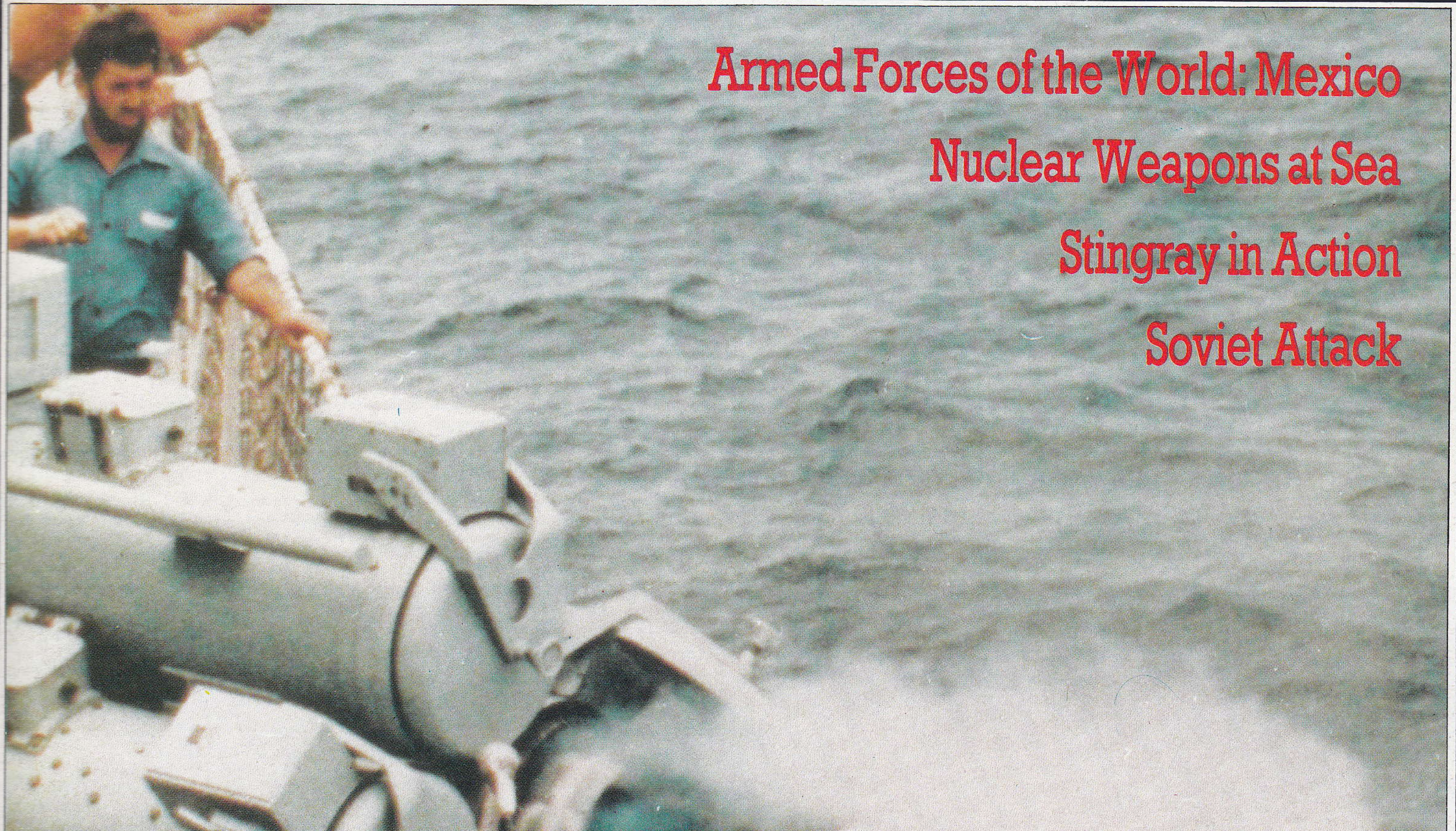

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WAR MACHINE

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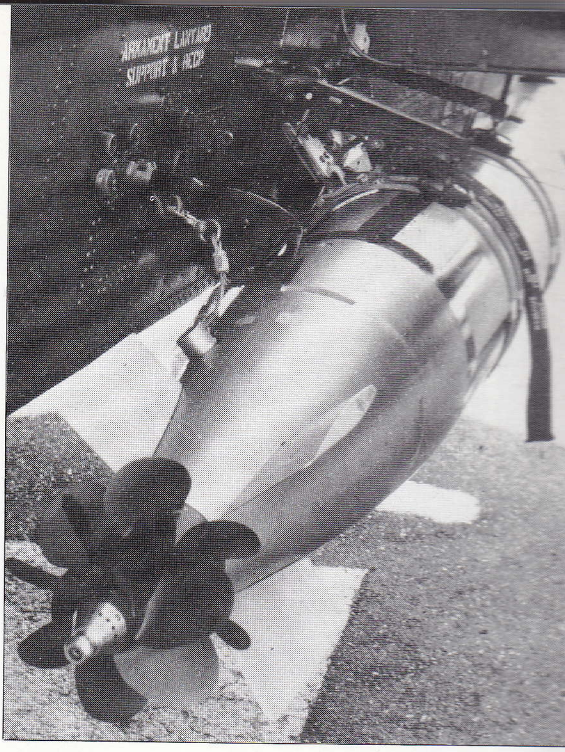
Modern Underwater Weapons



The modern lightweight torpedo, in combination with the dedicated anti-submarine helicopter, has extended the capability of ASW vessels to an enormous extent. This is an American Mk 46 torpedo attached to an SH-3 Sea King helicopter, a combination common to several NATO navies.

The technological revolution of the last four decades has seen a profound change in the waging of war at sea, with the torpedo replacing the depth charge as the major anti-submarine weapon and the torpedo itself being complemented or in some cases replaced in the anti-shipping role by the guided missile.

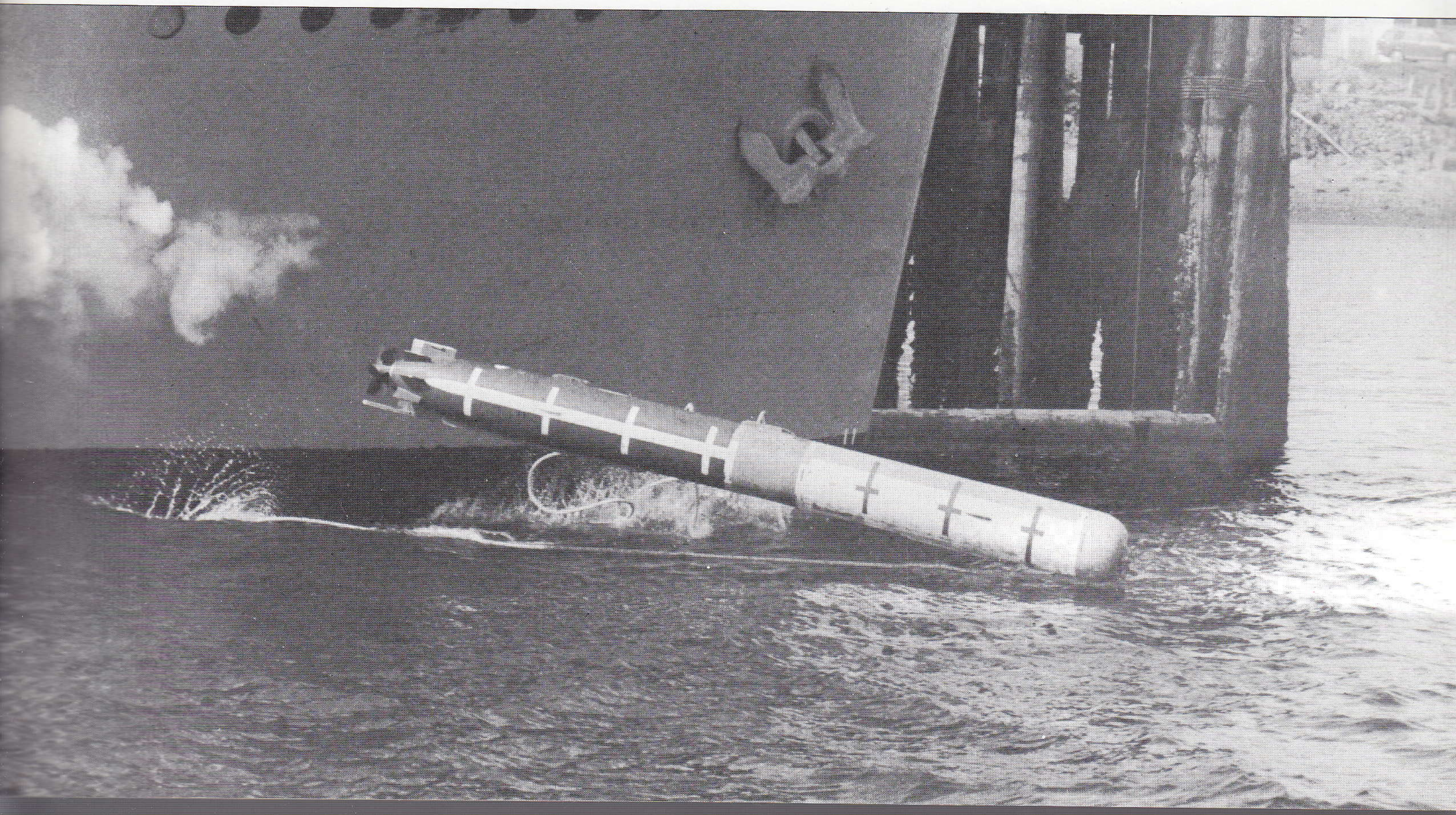
With the advent into service of the British Stingray lightweight ASW torpedo in the early 1980s, the era of the intelligent (or 'smart') weapon arrived in the field of torpedo technology. Already the Americans are moving fast to close the gap by replacing their outmoded Mk 46 weapons by the 'smart' Mk 50, whilst both the Royal and US Navies are working to field as early as possible new heavyweight torpedoes (in the form of the Spearfish and Mk 48 ADCAP respectively) to counter the new generation of faster and deeper-diving Soviet nuclear submarines that have just entered service.

At the same time the Soviets took the opportunity of springing their own surprise in torpedoes in the form of their Type 65 long-range wake-homing anti-ship weapon of 609.6-mm (24-in) calibre aboard attack vessels. Such weapons are backed by a wide range of standard 533-mm (21-in) calibre steam- and electric-powered models (with speeds ranging from 28 kts up to 45 kts or so) including the only nuclear-armed torpedo left in service with any navy. The Soviets also deploy a wide variety of smaller weapons mainly for ASW use. Surprisingly, it is only in the last few years that any reports of wire-guided weapons in service with the Soviets have surfaced, and to date these have not been substantiated.

Of the other torpedo-producing nations only Sweden has produced remarkably different designs. Its heavyweight Tp61 family is based on a hydrogen peroxide propulsion system of the type discarded by other Western countries such as the UK as being too dangerous to handle under operational conditions. And the Swedish lightweight Tp42 series is still the only Western torpedo of its class that can be guided by wire after an airborne launch.

For the next century there is the prospect of torpedo-like weapons used as robotic sub-surface vessels in the place of manned submarines. Such systems would be controlled from shore bases and form defensive barriers around friendly countries.

The launch of a modern heavyweight torpedo from a surface vessel has changed little from those launched from the destroyers and fast attack craft of World War II. What has changed, however, is the means by which the weapon is directed onto its target.



WEST GERMANY

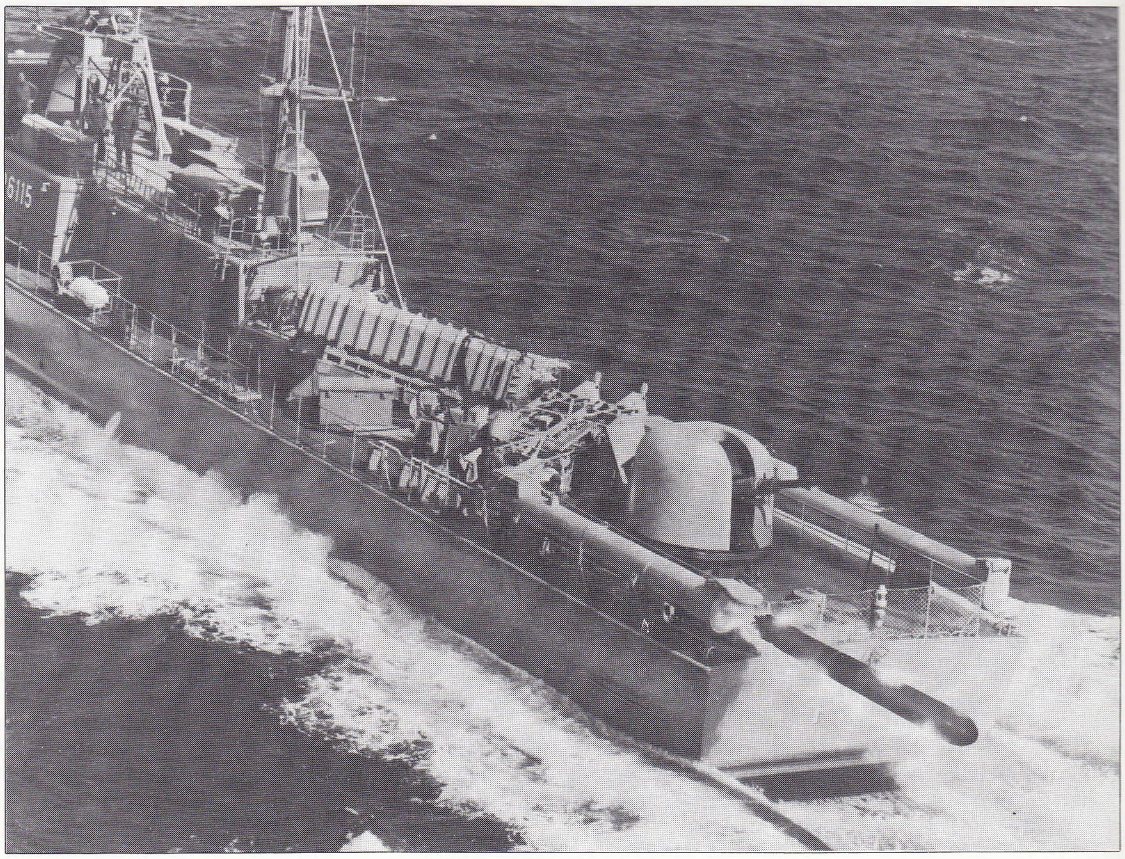
AEG-Telefunken Seal, Seeschlange, SST4 and SUT torpedoes

These AEG-Telefunken weapons constitute a complete family of heavyweight torpedoes. The basic electric-powered dual-speed **Seal** and **Seeschlange** (sea snake) were developed specifically for use by the West German navy, and are currently in use aboard its 'Type 205/206' submarines, whilst the Seal is also employed on some light forces' missile craft. There is a high degree of equipment commonality between the two weapons, the major difference being that the smaller ASW Seeschlange has only half the propulsive battery capacity of the anti-ship Seal. An active/passive homing head is fitted with a dual-core wire-guidance system that allows rapid changing between speeds, attack patterns and guidance modes in order to meet the needs of developing tactical situations.

The Seal was then taken as the model for the **Special Surface Target (SST) 4** torpedo, which except for certain features unique to West German operational requirements is comparable in dimensions, construction and capabilities to its predecessors. Used as the standard anti-ship weapon sold with export 'Type 209' submarines and West German missile craft, the SST4 is found in various NATO and South American navies, and was used operationally by the Argentine submarine *San Luis* during the 1982 Falklands war in several abortive torpedo attacks against Royal Navy task force ships.

The Seal was then further developed to produce the export **Surface and Underwater Target (SUT)** torpedo. As a dual-purpose ASW/anti-ship weapon capable of being launched from surface ships, submarines or shore positions, the SUT has the same shallow-water and deep-diving engagement capabilities of the other members of the family plus the same contact and magnetic proximity fusing systems. Like the SST4 it is in production for export with the 'Type 209' submarines.

Specification
Seal
Dimensions: diameter 533 mm (21 in); length 6.08 m (19.95 ft), or 6.55 m (21.49 ft) with wire guidance casket
Weight: 1370 kg (3,020 ft)
Warhead: 260-kg (573-lb) HE
Performance: speed 23 or 35 kts; range 28 or 12 km (17.40 or 7.46 miles)

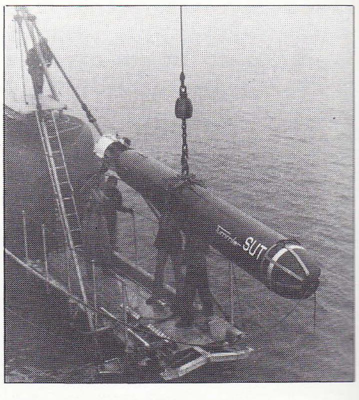


A missile-armed Type 143 fast attack craft of the West German navy makes a test launch of an AEG/Telefunken Seal torpedo. One of a family of weapons, it is designed for the engagement of surface targets, and is fitted to Type 142 and 143 boats as well as aboard Type 206 submarines.

Specification
Seeschlange
Dimensions: diameter 533 mm (21 in); length 4.15 m (13.62 ft), or 4.62 m (15.16 ft) with wire guidance casket
Weight: 800 to 900 kg (1,764 to 1,984 lb)
Warhead: 100-kg (220-lb) HE
Performance: speed 23 or 35 kts; range 14 or 6 km (8.70 or 3.73 miles)

Specification
SST4
Dimensions: diameter 533 mm (21 in); length 6.04 m (19.82 ft), or 6.50 m (21.33 ft) with wire guidance casket
Weight: 1414 kg (3,117 lb)
Warhead: 260-kg (573-lb) HE
Performance: speed 23 or 35 kts; range 28 or 12 km (17.40 or 7.46 miles)

Right: The Surface and Underwater Target (SUT) torpedo, seen being loaded aboard one of the widely exported 'Type 209' submarines, is the most versatile of the AEG-Telefunken heavyweight torpedo range. It is a dual-purpose weapon, wire guided for greater accuracy.



Specification
SUT
Dimensions: diameter 533 mm (21 in); length 6.15 m (20.18 ft), or 6.62 m (21.72 ft) with wire guidance casket
Weight: 1414 kg (3,117 lb)
Warhead: 260-kg (573-lb) HE
Performance: speed 23 or 35 kts; range 28 or 12 km (17.40 or 7.46 miles)

USSR

Soviet sea mines

The USSR is the world's leading exponent of sea mine warfare, with over 400,000 of such weapons in its naval weapons inventory. The mine types used include small, medium and large defensive moored mines using contact, influence or antenna activating systems. Known types include the **YaRM** and **YaM** spherical contact mines for rivers and shallow waters, the **M08** and **KB** series contact mines for coastal waters, and the **KRAB** moored influence and **MAG** moored antenna mines for coastal and deeper continental shelf waters. All of these are likely to be in service with Soviet client states such as the other members of the Warsaw Pact, many nations in the Middle East, and also Vietnam and North Korea.

The offensive mines are mainly ground mines, of which the most important are the **AMD-500** and **AMD-1000** types (the number referring to the relevant mine's nominal weight in kilograms). The AMD-500 contains 300 kg (661 lb) and the AMD-1000 700 kg (1,543 lb) of HE. Using magnetic, acoustic, pressure or combination influence actuating systems, these weapons have also been widely exported, evidence being provided by recent wars in the Middle and Far East. The pressure types are almost certainly used only by the USSR and her most trusted Warsaw Pact partners, however, because of the possibility of technology compromise and the fact that in other hands they may well be used against their designers eventually.

There are also growing Soviet stocks of rising mines and underwater electrical potential mines for use in the offensive ASW role against NATO targets. The two types of rising mine available can also be used in a secondary anti-ship role. These two types are believed to be the **'Cluster Bay'** continental shelf and **'Cluster Gulf'** continental ledge types in NATO terminology. There is also a small stockpile of nuclear-armed mines with yields between 5 and 20 kilotons for use against very high-value surface ships or submarines such as nuclear-powered aircraft-carriers and 'Ohio' class SSBNs.

The primary offensive minelaying platforms available to the Soviet navy are its conventionally-powered submarines because of their covert laying capabilities. These would be backed by aircraft of the Soviet naval air force, whilst any defensive laying would be the responsibility of surface ship units.

Specification
M08
Dimensions: diameter 0.90 m (2.95 ft); maximum case length 6.096 m (20.00 ft)
Charge weight: 115 kg (253.5 lb)
Maximum laying depth: 130 m (427 ft)

Specification
KB1
Dimensions: diameter 0.9 m (2.95 ft); maximum case length 9.144 m (30.00 ft
Charge weight: 230 kg (507 lb)
Maximum laying depth: 275 m (902 ft)

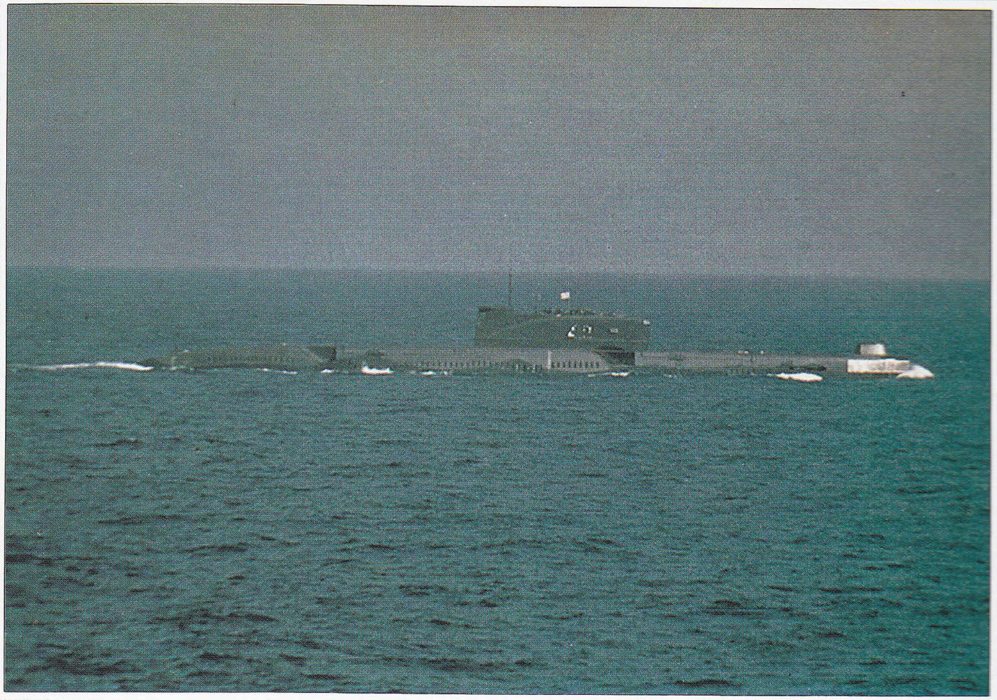
Soviet Attack

In the fortunately unlikely event of a major conflict erupting in Europe, a major Soviet aim must be to interrupt the sea lanes across the Atlantic in order to prevent the massive American reinforcement of Europe that NATO would require in order to hold Soviet ground forces on the Central Front.

In order for NATO to resist, halt and then drive back a Warsaw Pact attack into Western Europe, vast amounts of supplies and heavy equipment must be moved via the sea lines of communications (SLOCs) across the North Atlantic. Although many of the northern SLOCs would be open to joint interdiction by Soviet naval air force missile-carrying strike regiments and by surface ships and submarines, the southern ones would become the priority targets for submarines alone. Because of the distances involved and speed requirements to reach interception points, open-ocean attacks would be assigned to the nuclear-powered cruise missile and torpedo attack boats, whilst coastal waters, natural choke-points and port areas would become the hunting ground for the quieter conventionally-powered units.

The Soviet theory of submarine warfare continually stresses the mounting of co-ordinated attacks by a variety of mutually supporting plat-

Below: Soviet policy dictates the retention in service of otherwise obsolete vessels, often for use against less well-protected targets. The 'Juliett' class guided missile submarines are now over 20 years old, but could be used effectively against merchant convoys.

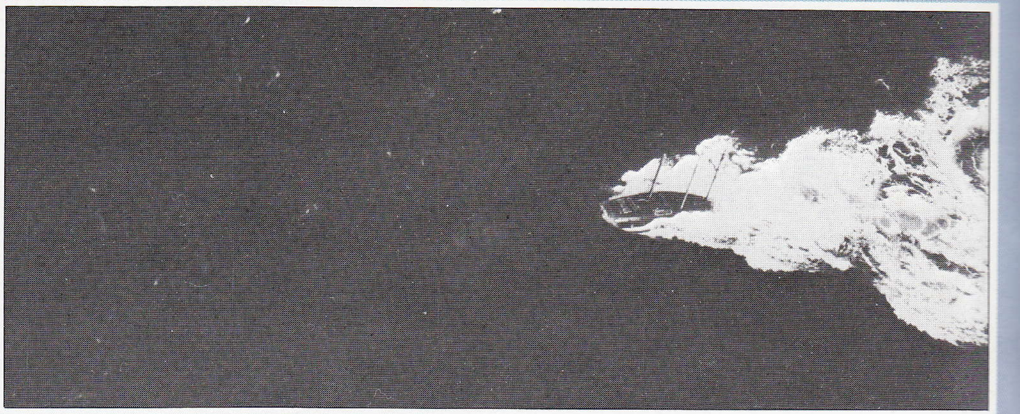


Below: The single 'Papa' class cruise missile submarine could well be the precursor of a series of submarines designed to take on the US Carrier Battle Group, as she is apparently a development of the 'Charlie' class incorporating some of the advanced technology of the ultra-high-speed 'Alpha' class.

forms. In the absence of aerial or surface ship support it is probable that an open-ocean assault on a convoy could involve up to 10 submarines. The initial detection of the convoy, the assessment of its subsequent route, the bringing together of the 'wolf-pack' and the formulation of the battle plan to engage it would be the responsibility of the Soviets' centralized shore-based command and control networks and intelligence-gathering platforms.

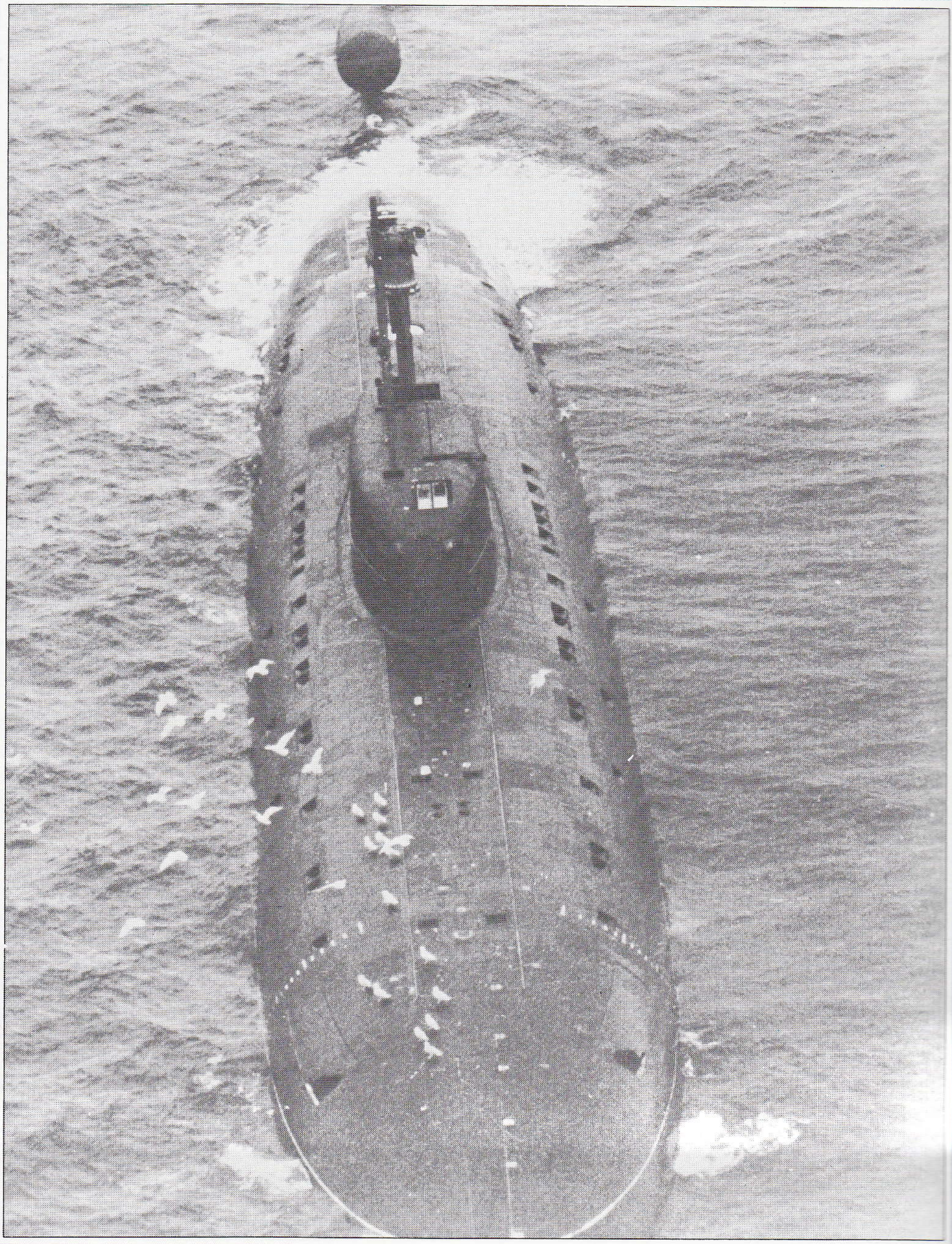
Detailed positioning

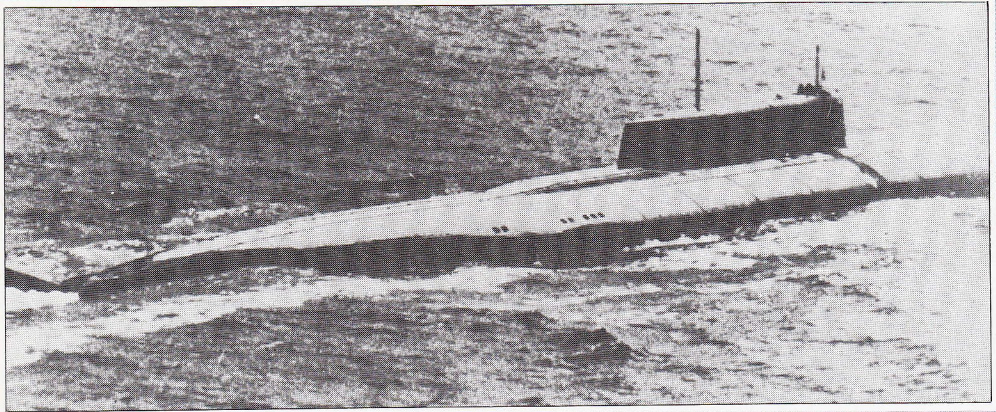
The detailed plan would require the positioning of SSNs and SSGNs (after high-speed transits from their patrol and holding areas) in specific sectors to avoid any possibility of interference. The range and bearing from the convoy's general position and route would be arranged according to the submarine's own armaments and their ability to disengage rapidly. The long-range missile attack element would be provided by two or three SSGNs equipped with SS-N-3 'Shaddock' or SS-N-12 'Sandbox' cruise missiles. These boats would surface at a prearranged time to launch a coordinated stream attack of missiles from several bearings on one side of the convoy in order to force the convoy and its escorts into a well defined air-defence deployment pattern and to cause as much confusions as possible. The initial missile in each salvo fired would also be used as an area reconnaissance system to send accurate convoy positioning data (via a data-link) back to the launch platform for follow-on missile targeting and for retransmission back through secure satellite communications channels to the command centre and as many of the other attacking units as possible. During the 460/560-km (285/350-mile) flight of the SS-N-3 and SS-N-12 missiles, which use medium- to low-altitude terminal attack profiles, one or two 'Charlie' class SSGNs would close to their own launch positions nearer to the convoy and on its opposite side to fire pairs of their own 55 km (34 mile) range SS-N-7 or 110-km (68-mile) range SS-N-9 'Siren' pop-up anti-ship cruise missiles. These terminal sea-skimming missiles would be timed to arrive amongst the ships after the bigger long-range missiles had hit, to cause even greater confusion and the adoption of yet more evasive manoeuvres within the convoy to counter them. To add further to the convoy's problems at this point, two to three of the SSNs lurking outside the convoy's ASW screen and equipped to carry and fire the massive Type 65 609.6-mm (24-in) wake-homing anti-ship torpedo would also have timed the launch of between eight and 12 of these high-speed weapons from astern or slightly abeam of the convoy from a range of some 30 to 50 km (18.6 to 31 miles) to arrive at about the time that the ships were turning to meet the new missile attack. A single hit from one of these torpedoes with its large explosive charge in the vicinity of target's steering gear would be enough to cripple it and leave it a sitting duck for any of the sea-skimming missiles. By this stage, and if all parts of the battle plan had been followed correctly and no trouble had been met, the convoy and its escorts would have been thrown into total disorder with many damaged or sinking ships littering its route. Any gaps opened in the ASW screen by the loss of an escort would then be exploited by the remaining SSNs lying in front of the convoy and outside the escort's active sonar range. These would penetrate the screen via the gaps and close to within some 16 km (10 miles) of the merchant ships to use



Above: A 'Victor' class nuclear-powered attack submarine submerges at the start of a patrol. Such boats would form the spearhead of any Soviet attack on the Atlantic jugular, duelling with defending NATO hunter-killer submarines in the icy depths.

Below: A 'Sierra' class attack submarine is seen underway to the north of Norway. Enlarged versions of the very capable 'Victor III', the 'Sierras' could well make long-range attacks using SS-NX-21 cruise missiles or the new wake-homing 610-mm (24-in) very long-range torpedo.

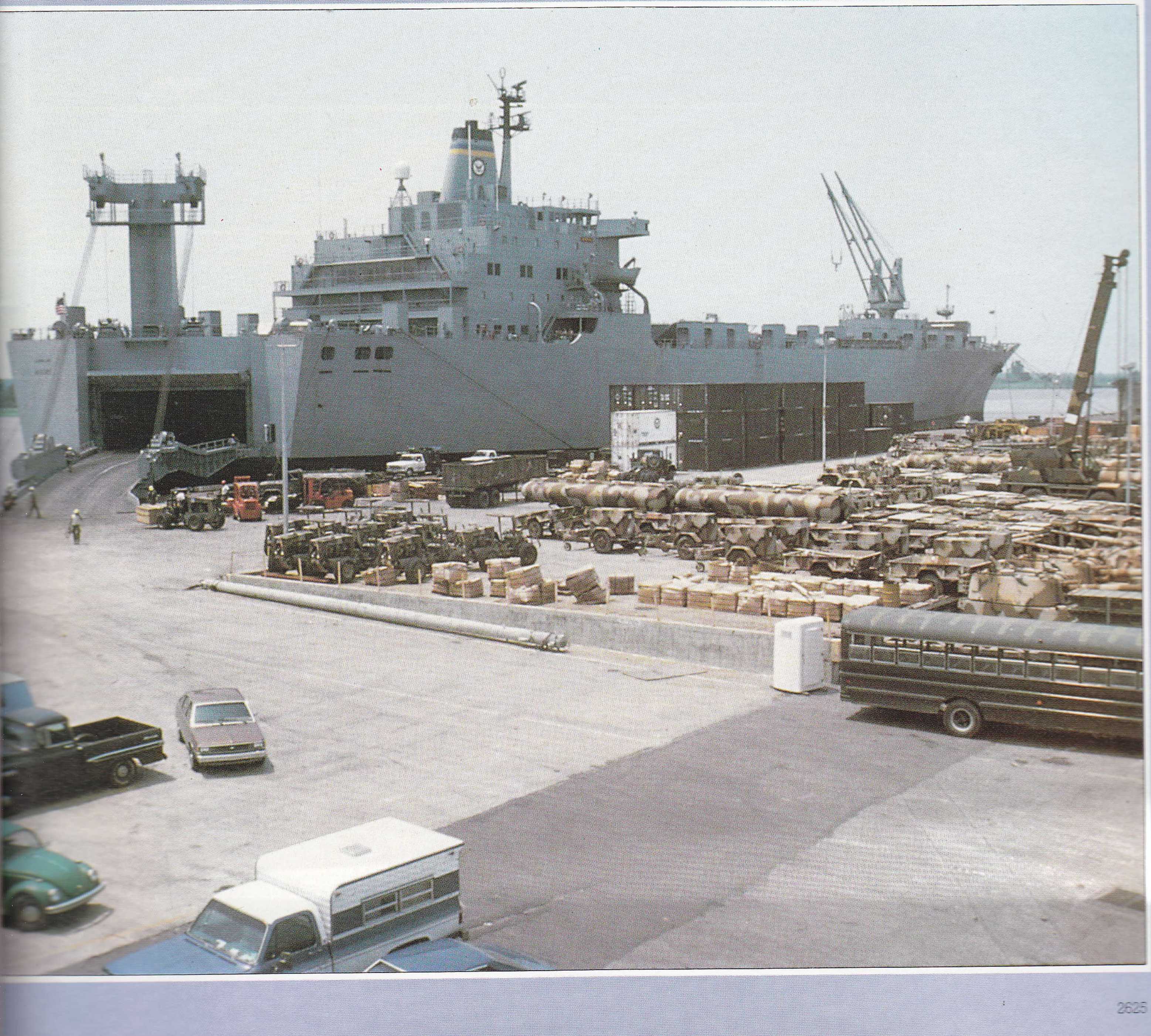


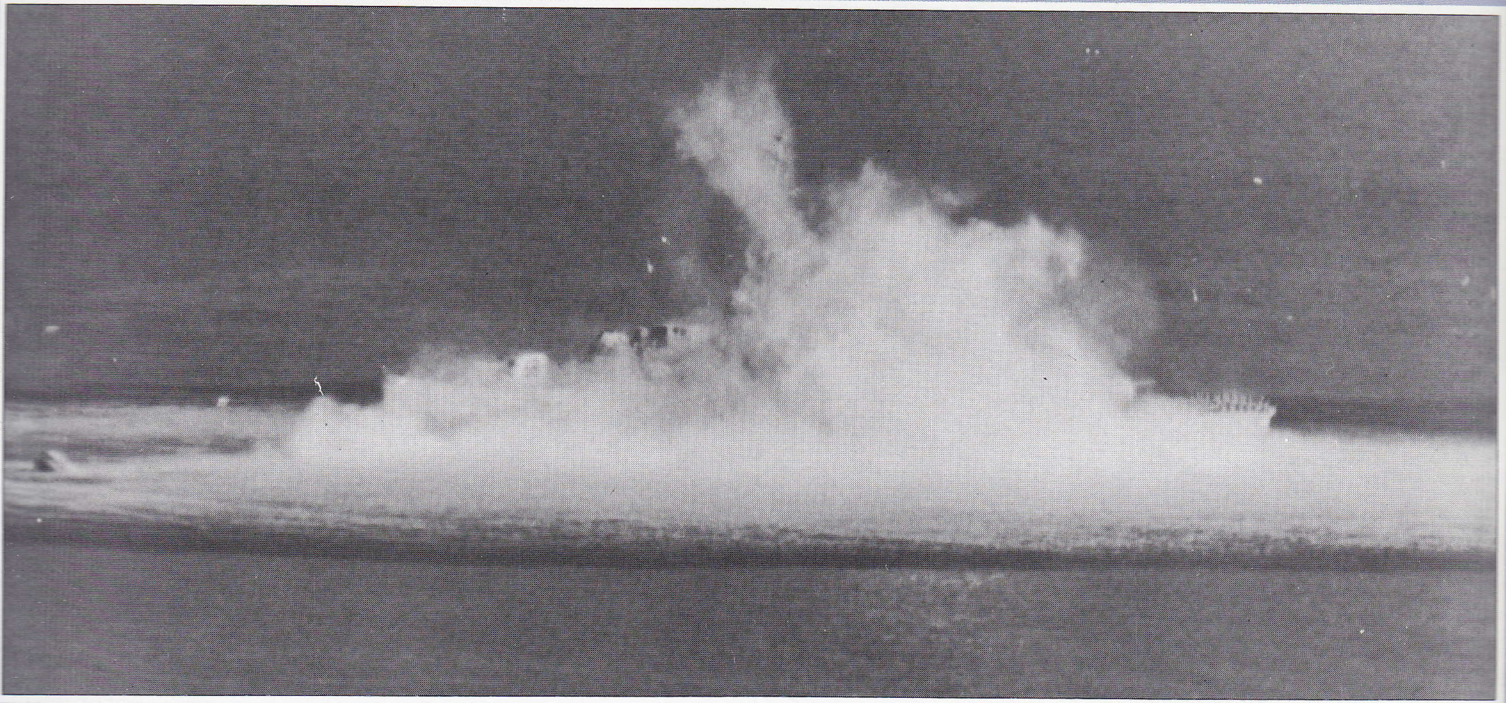


Above: The very large 'Oscar' class cruise missile submarine is armed with the 270 nautical mile ranged SS-N-19, which also forms the main strike weaponry of the nuclear powered 'battlecruiser' Kirov.

Below: The loading of the Military Sealift Command ship USNS Mercury *at the port of Wilmington shows the wide range of stores and equipment that would be shipped across the Atlantic.*

Above: The transport vessel American Ranger *is loaded for supplies for the reinforcement of Europe at the start of one of the regular 'Reforger' exercises designed to test US capacity to react to a crisis on the Central Front.*





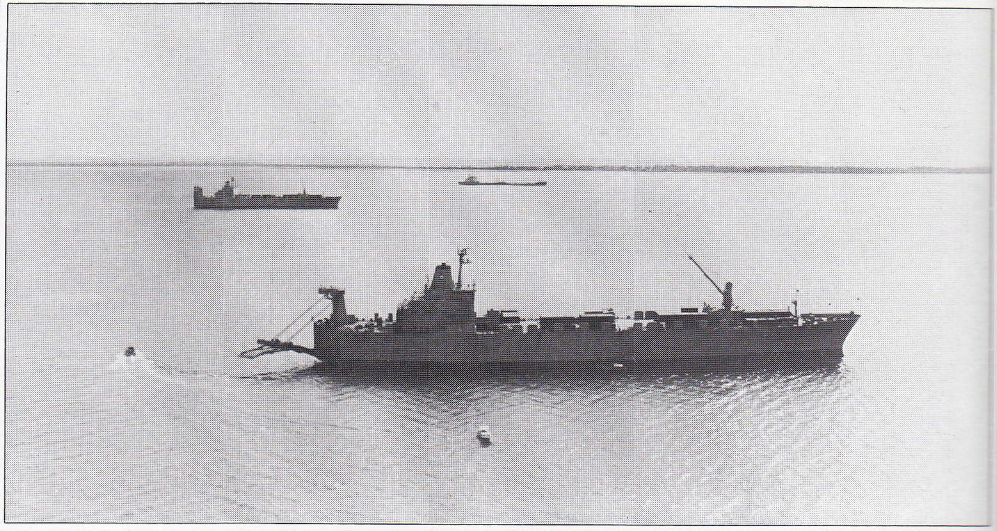
their speed and main armament of straight- and pattern-running 533-mm (21-in) anti-ship torpedoes and acoustic-homing weapons to finish off damaged targets and sink as many as possible of the undamaged ones. In the event of heavy resistance to these SSNs or the need for further short-range torpedo attacks, then the SSNs used in the long-range stern or beam torpedo attacks would be vectored in the the central command authority from their weapon launch positions to apply the *coups-de-grace*.

Of course the above scenario is idealized from the Soviet point of view, and takes no account of the presence of a western surface ship hunter-killer group with long-range passive towed arrays, large numbers of ASW helicopters, overhead maritime patrol aircraft and subsurface protection in the form of an SSN or two using long-range passive sonars to detect the Soviet submarines manoeuvring at speed into their attack positions. However, the scenario is believed to contain all of the current conventional attack options available to Soviet fleet commanders when using only subsurface units in an attack on a reinforcement convoy in mid-Atlantic.

The use of nuclear warheads on the missiles and torpedoes would bring a whole new outlook to the scenario, as area rather than individual targeting options would immediately become possible. This would reduce the number of attacking units required to inflict on a convoy the same or (more probably) a higher level of damage. Likewise the use of tactical nuclear ASW weapons by the defending force could easily inflict enough losses on the attacking submarines effectively to disrupt the Soviet battle plan before it can become effective. What is apparent, however, is that regardless of the scenario suggested the actual battle to get the convoys across the Atlantic would be harder and more costly to both sides than any fought between the Allies and Nazi Germany's U-boats during World War II. As more than one American admiral has put it, only a steam roller operation will do the job and even then you dare not try to count the losses but only the tonnage delivered.

Above: One of the first targets for attacking Soviet submarines would be the escorts. The most capable ASW vessels in the US Navy are assigned to the defence of the high-value carrier battle groups, with less capable vessels protecting the supply convoys.

Below: In the event of a crisis in central Europe, the US could be able to call upon the pre-positioned vessels of the Rapid Deployment Joint Task Force, which could be underway from their Indian Ocean bases and into the Mediterranean in days rather than weeks.

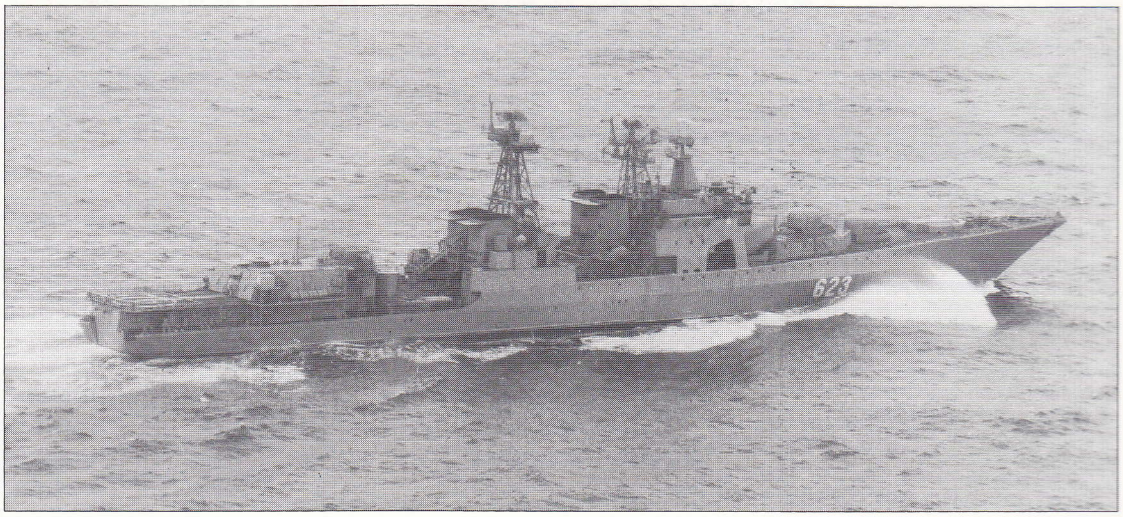


Important vessels in the resupply lifeline would include the US Navy's specialist ammunition ships, such as USS Kiska. One certainty which was highlighted by the Falklands experience is that high-tech war will mean enormous expenditures of weaponry.

The end result of the entire effort is demonstrated by the unloading of supplies on the docks at Rotterdam. It is essential that in any conflict the NATO forces hold the Warsaw Pact advance until the major American reinforcements arrive in Europe.

USSR

Soviet torpedoes



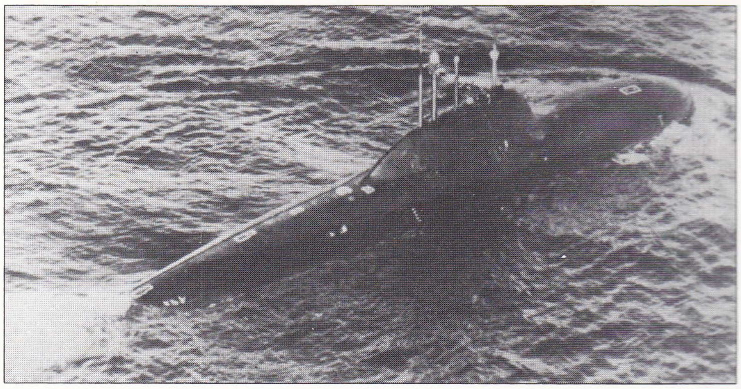
Above: The Vitse-Admiral Kulakov *is the second of the large ASW destroyers of the 'Udaloy' class. In addition to her ASW missiles and helicopters, she is armed with two quadruple 533-mm (21-in) torpedo tubes, one of which is visible astern of the aft funnel structure.*

Soviet torpedoes, like their Western counterparts, can be categorized into heavy and lightweight models for specific purposes. Of the former, two calibres are known: the standard 533 mm (21 in) and the relatively new 609.6 mm (24 in). The 533-mm (21-in) versions are thought to have been evolved from German World War II designs, and include straight- and pattern-running surface- and submarine-launched steam- or electric-powered models for anti-ship use, as well as acoustic/passive homing ASW/anti-ship versions. Surprisingly, most large modern surface combatants have multi-tube launchers for the ASW acoustic-homing versions. There is also a special 15-kiloton yield nuclear-armed non-terminal-homing 533-mm (21-in) torpedo in service on many of the submarines designed for use against high-value surface targets such as carriers or Very Large Crude Carriers. Similarly the huge 9.14-m (30-ft) long 609.6-mm (24-in) anti-ship **Type 65** torpedo has been introduced on board later-generation nuclear attack submarines for use against surface ship targets. It is believed to use wake-homing guidance methods and, with selectable 50- or 30-kt speeds, has ranges of 50 and 100 km (31 or 62 miles) respectively. With ranges like these, the Type 65 is being used to supplement the pop-up anti-ship cruise missile weapons of 'Charlie' class SSGNs, and the type's availability for the first time allows Soviet SSNs to fire torpedoes from outside the ASW screen of a convoy.

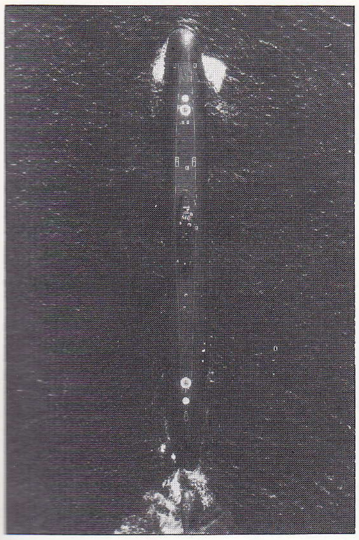
For air, shipboard and submarine ASW uses at close range a 400-mm (15.75-in) electric-powered lightweight torpedo has been in service for a number of years. This has now apparently been supplemented for use aboard ASW aircraft and helicopters by an even larger 450-mm (17.7-in) weapon which is believed to have a larger warhead and greater range to increase lethality. Both the air-launched weapons use parachutes to retard their entry into the water.

According to some reports there is also a short 400-mm (15.75-mm) anti-ship torpedo which is found aboard the first-generation 'Hotel', 'Echo' and 'November' class nuclear submarines in their stern tubes. The later-generation nuclear submarine classes apparently have had several of their standard 533-mm (21-in) calibre torpedo tubes fitted with liners to fire the ASW version of the same weapon.

The standard fusing system fitted to Soviet torpedoes is an active magnetic proximity device (to ensure detonation under the target's hull so as to break its back) with a secondary contact unit for a direct hit.



Above: The 'Alfa' class submarine is considerably shorter than other Soviet SSN designs, so it is unlikely to have been fitted to fire the massive 610-mm (24-in) torpedo reportedly in service with the Soviet navy although it may be armed with the strategic SS-N-21 Cruise missile.

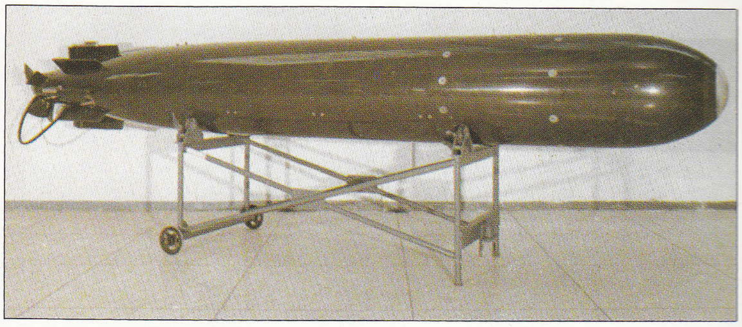


Above: Photographed by a US Navy F-14 fighter, this 'Victor III' SSN has fouled the towed array sonar of a 'Spruance' class destroyer off the coast of Georgia. These large boats may be fitted with the extremely long-ranged 610-mm (24-in) torpedo, which allows attacks from as far as 100 km (62 miles).

Below: Backbone of the Soviet anti-submarine force, the 'Krivak' class, like all major Soviet vessels, is fitted with torpedo tubes. The eight tubes abaft the bridge, in quadruple mounts port and starboard, probably fire acoustically-homing 533-mm (21-in) torpedoes.

FRANCE

DTCN L3, L4 and L5 torpedoes



The Sintra-Alcatel-built L3 is a conventional ship- or submarine-launched active acoustic homing anti-submarine torpedo. Unusually, it has a diameter of 550 mm (21.65 in) but has been offered in the more standard 533 mm (21 in) for export. It is in widespread French naval service.

The electric-powered 550-mm (21.7-in) calibre **L3** ship- or submarine-launched ASW homing heavyweight torpedo is currently in service with the French navy and was designed by the Direction Technique des Constructions Navales to attack submerged targets at depths up to 300 m (984 ft) and speeds from 0 to 20 kts. It is fitted with an AS-3T active acoustic guidance system that has a detection range of about 600 m (1,969 ft) in ideal conditions, and the warhead is detonated by an electro-magnetic proximity fusing system. A 533-mm (21-in) version with the same performance is available for export, length and weight being 4.318 m (14.17 ft) and 900 kg (1,984 lb). Apart from France, several of the countries (including Spain) which have bought 'Daphné' class submarines have also obtained the larger-calibre weapon.

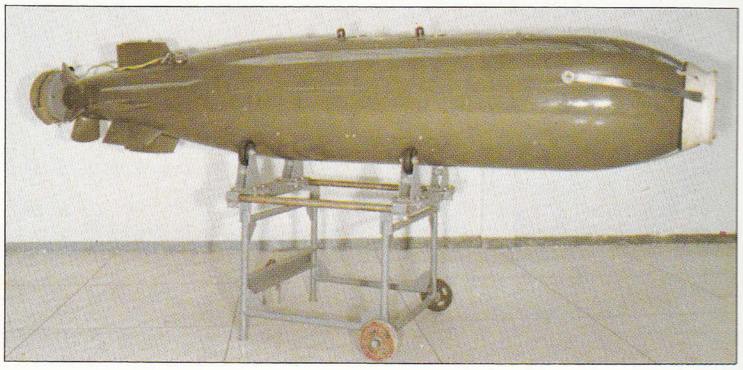
Also in service with the French navy is the 533-mm (21-in) electric-powered **L-4** air-launched torpedo for use with helicopters, aircraft and the Malafon ASW missile. Fitted with an active acoustic-homing system, it describes a circular search path upon entering the water until its seeker acquires the target. The warhead is detonated either by an impact fuse or a proximity acoustic influence fuse. French L4s have recently been modernized to improve shallow-water performance and its 0/20-kt target capability from periscope depth to around 300-m (984-ft) deep cruising. A version for surface ship launching has also been developed: this has a length of 3.30 m (10.83 ft) and a weight of 570 kg (1,257 lb).

The most recent of the L-series torpedoes is the electric-powered **L5**, which is available in four versions. The dual-purpose ASW/anti-ship **L5 Mod 1** is carried by surface ships, whilst the similar-role but heavier **L5 Mod 3** is used by submarines. A single-role variant, the ASW **L5 Mod 4**, has been derived from the Mod 1 and is used solely by surface ships. A further version of this has been developed for the export market as the **L5 Mod 4P** multi-role torpedo. All versions are fitted with a Thomson CSF active/passive guidance system and are capable of various attack profiles including direct and programmed searches using either of the acoustic homing techniques available. Known operators of the L5 other than France include the Belgian navy (L5 Mod 3) and Spain (aboard submarines).

Specification
L3
Dimensions: diameter 550 mm (21.7 in); length 4.30 m (14.11 ft)
Weight: 910 kg (2,006 lb)
Warhead: 200-kg (441-lb) HE
Performance: speed 25 kts; range 7.5 km (4.66 miles)

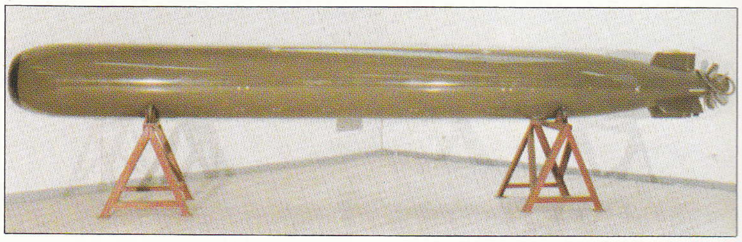
Specification
L4
Dimensions: diameter 533 mm (21 in); length 3.033 m (9.95 ft), or 3.13 m (10.27 ft) with parachute pack
Weight: 540 kg (1,190 lb)
Warhead: 104-kg (229-lb) HE
Performance: speed 30 kts; range 5.5 km (3.4 miles)

Specification
L5
Dimensions: diameter 533 mm (21 in); length 4.40 m (14.44 ft)
Weight: (Mod 1) 1000 kg (2,205 lb), (Mod 3) 1300 kg (2,866 lb), (Mod 4) 920 kg (2,028 lb) and (Mod 4P) 930 kg (2,050 lb)
Warhead: 150-kg (331-lb) HE
Performance: speed 35 kts; range 9.25 km (5.75 miles)



Above: The L4 air-launched torpedo can function in shallow water against submarines manoeuvring at up to 20 kts. It also provides the warload for the Malafon ASW missile system, and a ship-launched version has been designed.

Below: The L5 series of multi-purpose torpedoes is fitted with Thomson-CSF active/passive homing heads, although the Mod 1 is intended for surface vessel use and the heavier Mod 3 version (shown here) equips submarines.

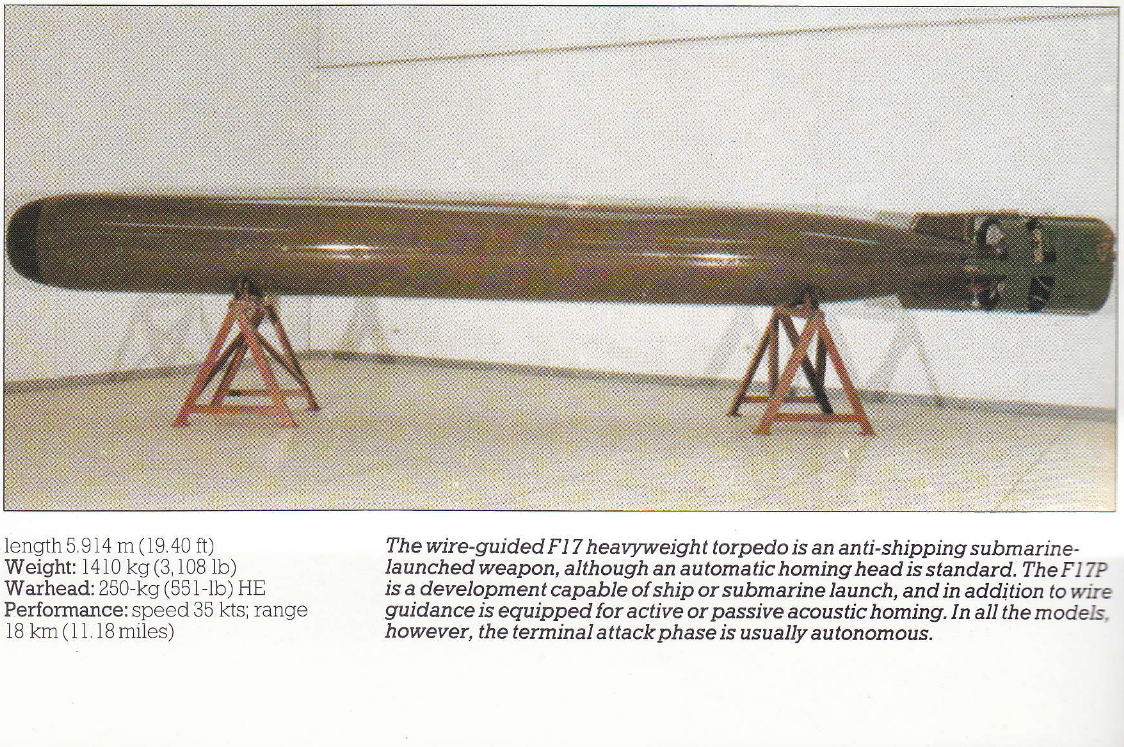


FRANCE

DTCN F17 torpedo

The **F17** is the first wire-guided heavyweight torpedo to be used by the French navy. Designed for use against surface ships from submarines, the weapon can be employed either in the wire-guided mode or in an autonomous passive homing mode, the capability for instant switching between the two modes being provided on a control panel aboard the launch platform. The terminal attack phase is normally of the passive acoustic type under the torpedo's own internal control. A dual-purpose surface- or submarine-launched variant, the **F17P**, has also been developed for the export market, and has been bought by Saudi Arabia for use aboard its 'Madina' ('Type F2000') class frigates, and by Spain for use aboard its 'Agosta' and modernized 'Daphné' class submarines. The F17P differs from the basic F17 in having an active/passive acoustic-homing seeker which allows completely autonomous operation if required.

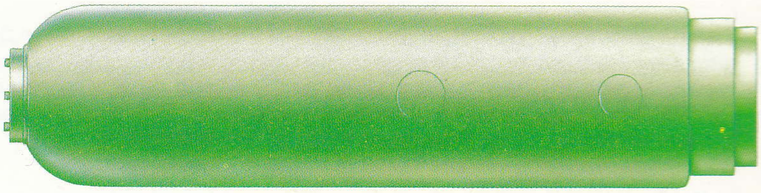
Specification
F17
Dimensions: diameter 533 mm (21 in); length 5.914 m (19.40 ft)
Weight: 1410 kg (3,108 lb)
Warhead: 250-kg (551-lb) HE
Performance: speed 35 kts; range 18 km (11.18 miles)



The wire-guided F17 heavyweight torpedo is an anti-shipping submarine-launched weapon, although an automatic homing head is standard. The F17P is a development capable of ship or submarine launch, and in addition to wire guidance is equipped for active or passive acoustic homing. In all the models, however, the terminal attack phase is usually autonomous.

FRANCE

Thomson-CSF sea mines



As offensive mines have to be laid covertly, often in or near enemy waters, the most appropriate system for such work is the submarine. Hence the TSM 3510, in common with many other mines in production today, is designed to be ejected through standard torpedo tubes.

Thomson-CSF produces two types of operational sea mine. The **TSM3510** (or **MCC23**) is an offensive ground mine fitted with a multi-sensor fusing system based on two or all of the magnetic, acoustic and pressure actuating influences, and is shaped for launching from the standard torpedo tube of a submarine. The sensitivity of the fusing can be adjusted before laying to suit the depth of water and the type of target likely to be encountered. The mine is armed (by withdrawing two safety pins) before it is loaded into the tube and is activated by a preset timing delay to allow the submarine to clear the area. Two similarly shaped training mines, the **TSM3515 (MCED23)** and the **TSM3517 (MCEM23)**, are also in service.

For defensive purposes there is the **TSM3530 (MCT15)**, which is a ground mine deployed from surface ships fitted with mine rails. It is checked in its descent to the sea bottom by a parachute-retarding device which ensures that correct orientation is achieved. It is armed by a preset timing delay which allows the laying platform to clear the area.

Both mines are in service with the French navy and have been sold abroad, especially the TSM3510 which is found in several of the countries that have purchased 'Daphné' class submarines.

Specification
TSM3510
Dimensions: diameter 0.53 m (1.74 ft); length 2.368 m (7.77 ft)
Weight: 850 kg (1,874 lb)
Actuating sensors: combination magnetic acoustic, magnetic pressure, acoustic pressure, or magnetic acoustic pressure

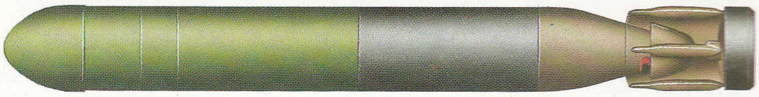
Specification
TSM3530
Dimensions: diameter 1.20 m (3.94 ft); length 1.10 m (3.61 ft)
Weight: 1200 kg (2,646 lb)
Actuating sensors: combination magnetic acoustic, magnetic pressure, acoustic pressure, or magnetic acoustic pressure

UK

Marconi Stingray torpedo

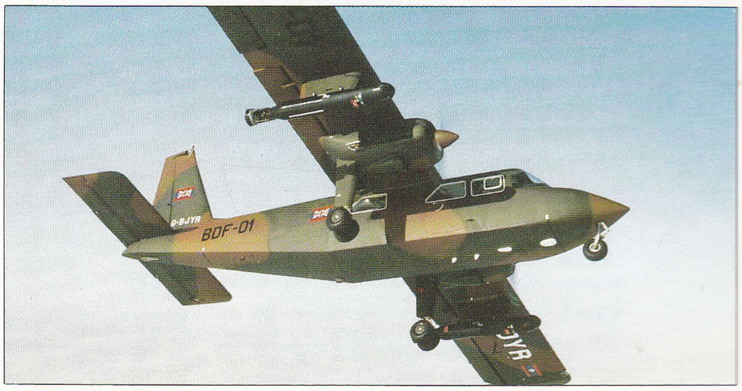
Designed to supplement the American Mk 46 Mod 2 and to replace the Mk 44 torpedoes in British service, the **Marconi Stingray** lightweight torpedo was the sequel of the abortive MOD in-house lightweight Mk 30 and 31 programmes, which were cancelled in 1970. The Stingray is the first British torpedo to be developed entirely by private industry and incorporates a number of technical innovations. The weapon is capable of being launched from helicopters, aircraft and surface ships over a wide range of speeds and sea states and, as a result of its unique guidance system, can be used satisfactorily in both shallow and deep waters with an equally high single-shot kill probability, the former being demonstrated recently during a development trial shot when Stingray dropped from a BAe Nimrod of No. 42 Squadron hit and sank the decommissioned conventional submarine *Porpoise*, apparently whilst she was moored at periscope depth.

Although deployed operationally aboard several ships during the 1982 Falklands war, Stingray was not fired in anger and did not actually enter full-scale service with the Royal Navy and Royal Air Force until 1983. Since then the weapon has been sold to Thailand and Egypt. In terms of general performance it is similar to the Mk 46 though, it seems, the British torpedo has slightly deeper diving depth of 800 m (2,625 ft). The Stingray also possesses an onboard digital computer coupled to a multi-mode multi-beam active/passive sonar that effectively makes it a 'smart' weapon. Propulsion is by an electrically-driven pump-jet with a battery activated by sea water that ensures no speed loss as the depth increases. The warhead is of the directed-energy shaped-charge variety rather than blast type to ensure penetration of a Soviet submarine's double-hull construction.



Similar in size to the previous generation of lightweight torpedoes, the Marconi Stingray also has a similar performance. Where it differs is in the sophisticated guidance.

Specification (provisional)
Stingray
Dimensions: diameter 324 mm (12.75 in); length 2.6 m (8.52 ft)
Weight: 265.4 kg (585.2 lb)
Warhead: 40-kg (88-lb) shaped-charge HE
Performance: speed 45 kts; range 11.1 km (6.9 miles)



Right: The new generation of lightweight torpedo gives significant anti-submarine capability to relatively unsophisticated systems. The Britten-Norman Defender could carry Stingray and could use its sophisticated electronics to attack the most advanced of submarines.

In addition to its primary air launch mode, Stingray will form a part of the ASW armament of several classes of Royal Navy surface combatant. The torpedoes will be launched from modified versions of the US Mk 32 triple tubes, as shown here in a trial launch from the Type 21 frigate HMS Avenger.

Stingray in Action

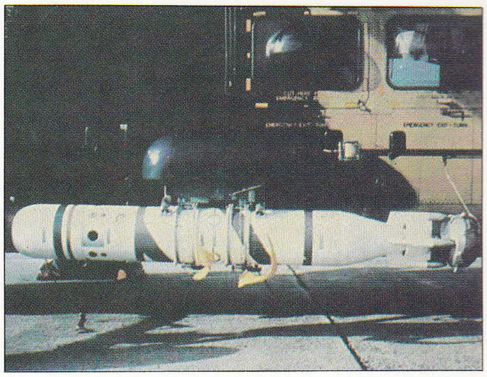
The phenomenal growth in the power of the Soviet navy in the past two decades has nowhere been so prominent as in the development of the submarine. New technologies applied to submarine and weapon design have provided a challenge to NATO, and one of the most sophisticated of NATO's replies has been the advanced lightweight Stingray torpedo.

The advent of the high-speed deep-diving 'Alpha' SSN and 'Papa' SSGN anechoic-coated submarine classes at the beginning of the 1970s presented major problems to NATO ASW planners in that the standard lightweight torpedoes in use at the time, the Mk 44 Mod 1 and the Mk 46 Mod 0/1/2, had totally inadequate homing and underwater performances to meet this threat. Although a modification programme was eventually initiated in an attempt to redress the balance (on the seeker side at least) for the Mk 46 under the title NEAR-Term Improvement Program (NEARTIP), it was later revealed by several American admirals during Congressional testimony that the NEARTIP conversion had only resulted in upgrading the Mk 46s to handle the pre-'Alpha' generation of submarines coated with the same anechoic coatings found on the newer boats.

In the midst of all this, and as a final result of the cancellation of the British Ministry of Defence's Mk 31 324-mm (12.75-in) calibre interim lightweight torpedo project in 1970, contracts were placed with Marconi for the design, development and initial production of an autonomous acoustic-homing torpedo initially known as Naval Staff Requirement 7511 or 'Son of Mk 31', and finally as Stingray. As part of the US Navy's similar Advanced Lightweight Torpedo (ALWT) programme initiated in August 1975, the Stingray was evaluated for possible US procurement. However, the Americans found that although its new shaped-charge warhead and advanced active/passive acoustic seeker with integral computer gave it an unrivalled target detection and destruction capability in comparison with the Mk 46 Mod 5, the Stingray was very much more expensive and had only similar underwater speeds, maximum diving depth and endurance characteristics, which were precisely the areas in which the US Navy was looking for marked improvements. It was also pointed out that a new-type propulsion system rather than the electric-battery type fitted would probably resolve these operational limitations.

Royal Navy use

Despite these American observations about Stingray, the Royal Navy stuck with its choice and ordered the weapon in significant quantities for use aboard its surface ships and helicopters. The Royal Air Force has also adopted it for the main armament of its BAe Nimrod MR.Mk 2 maritime patrol aircraft, which can each carry up to nine Stingrays in the internal weapons bay. On Royal Navy helicopters the load is usually one or two on a Westland Lynx HAS.Mk 2/3 and up to four on a Westland Sea King HAS.Mk 2A/5.



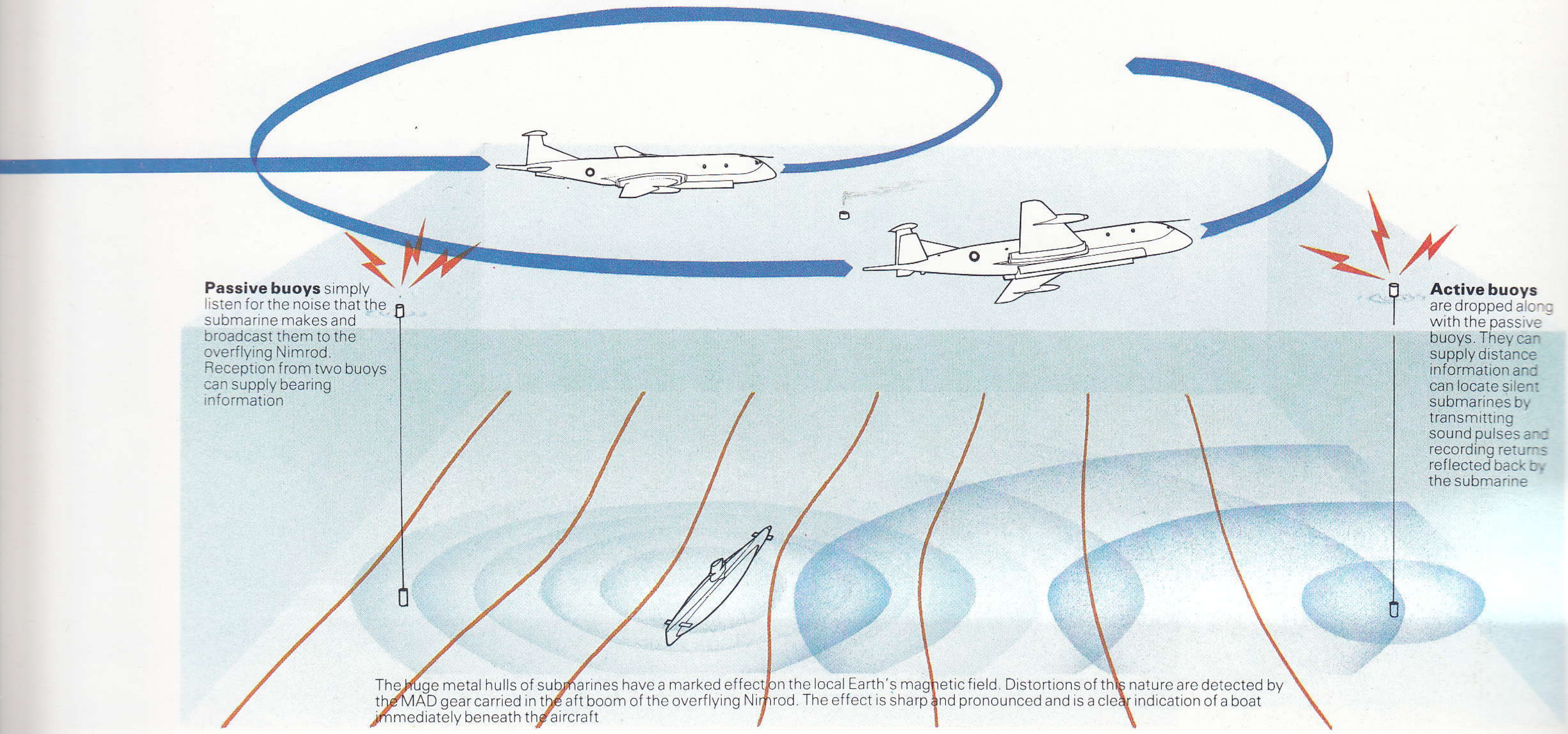
Marconi's Stingray exhibits all the qualities of a modern ASW weapon, being light enough to be transported by small helicopters yet fast enough to cope with the most modern nuclear submarines.

On surface ships the Stingray is launched from the port and starboard 325-mm (12.75-in) calibre triple torpedo tubes of the quick-reaction Ship's Torpedo Weapon System-2, which is a second-generation development by a British firm of the US Navy's Mk 32 torpedo-launcher unit and is integrated into the ship's Action Information Organization (AIO). At present STWS-2 is fitted on certain 'Leander' class frigates, all batches of the 'Type 22' class ASW ships and some of the 'Type 42' class destroyers. In the future it will be fitted aboard the new 'Type 23' 'Duke' class ASW frigates.

Under normal circumstances, in all shipboard cases the mode of operation is for the STWS-2 microprocessor-based tracker and predictor systems to receive on an automatic

The MAD attack

As Nimrod patrols in radio and radar silence, one of the crew eyeballs a surfaced submarine. Immediately a smoke flare is dropped and the aircraft circles the area of the now crash-dived boat at low level and in tight radius. Nimrod sows active and passive buoys while in the turn, and each crew member searches the array of sensors for a further sighting



Passive buoys simply listen for the noise that the submarine makes and broadcast them to the overflying Nimrod. Reception from two buoys can supply bearing information

Active buoys are dropped along with the passive buoys. They can supply distance information and can locate silent submarines by transmitting sound pulses and recording returns reflected back by the submarine

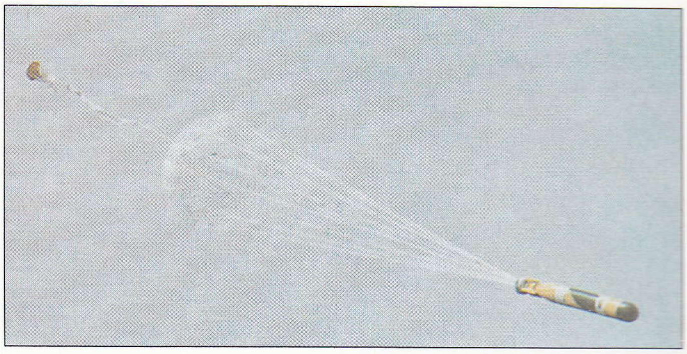
The huge metal hulls of submarines have a marked effect on the local Earth's magnetic field. Distortions of this nature are detected by the MAD gear carried in the aft boom of the overflying Nimrod. The effect is sharp and pronounced and is a clear indication of a boat immediately beneath the aircraft basis target data via an information channel from the main AIO unit. These data are passed to the tracker, which then computes the target's current position and displays the fire-controlled problem. The computed data is also passed into the predictor, which in turn computes the target's predicted course and uses this information (together with data on the ship's own heading, speed etc.) to generate and display the actual fire-control solution that optimizes the probability of seeker acquisition for the weapon to be used. The ship's Principal Warfare Officer (Underwater) can then use the action channel of the system to select and preset launch details into the most appropriate weapon of the six available to him in the tubes.

Once the launch point has been reached the torpedo is ejected from its tube on the rough bearing to the target and retarded in flight by a small drogue parachute to ensure the correct nose-first attitude for entering the water.

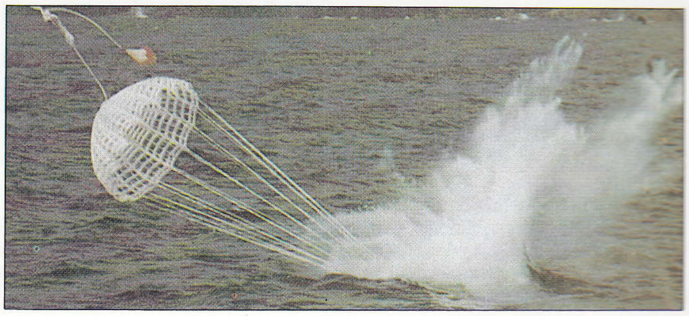
Search pattern commenced

Once the weapon has submerged, the parachute is discarded and the weapon makes for the target's predicted location to start its search pattern. The onboard computer and the multibeam active/passive sonar enable the Stingray to make its own tactical decisions during an engagement by anticipating a target's changes of course, speed and depth throughout analysis of information it is receiving. The software is also powerful enough to reject any countermeasures techniques such as towed noisemakers, ejected acoustic jammers or mobile decoys that may be deployed by the target. It also ignores any extraneous background noise of the marine environment, which has been known to seduce earlier torpedo types from their search patterns. Once locked on to a validated target, Stingray is thus virtually impossible to shake off unless the submarine is fast enough to outrun it (assuming that it has detected the noise of the weapon homing in).

The computer guides the torpedo to the optimum point on the target, where the shaped-charge warhead is exploded by a direct contact fuse so that all of the force of the blast is directed into penetrating the pressure hull. At any depth the effect of the explosion on a submarine is readily apparent, whilst at shallower depth the damage should be more than sufficient either to cause the vessel to sink deeper (where a catastrophic hull failure would occur

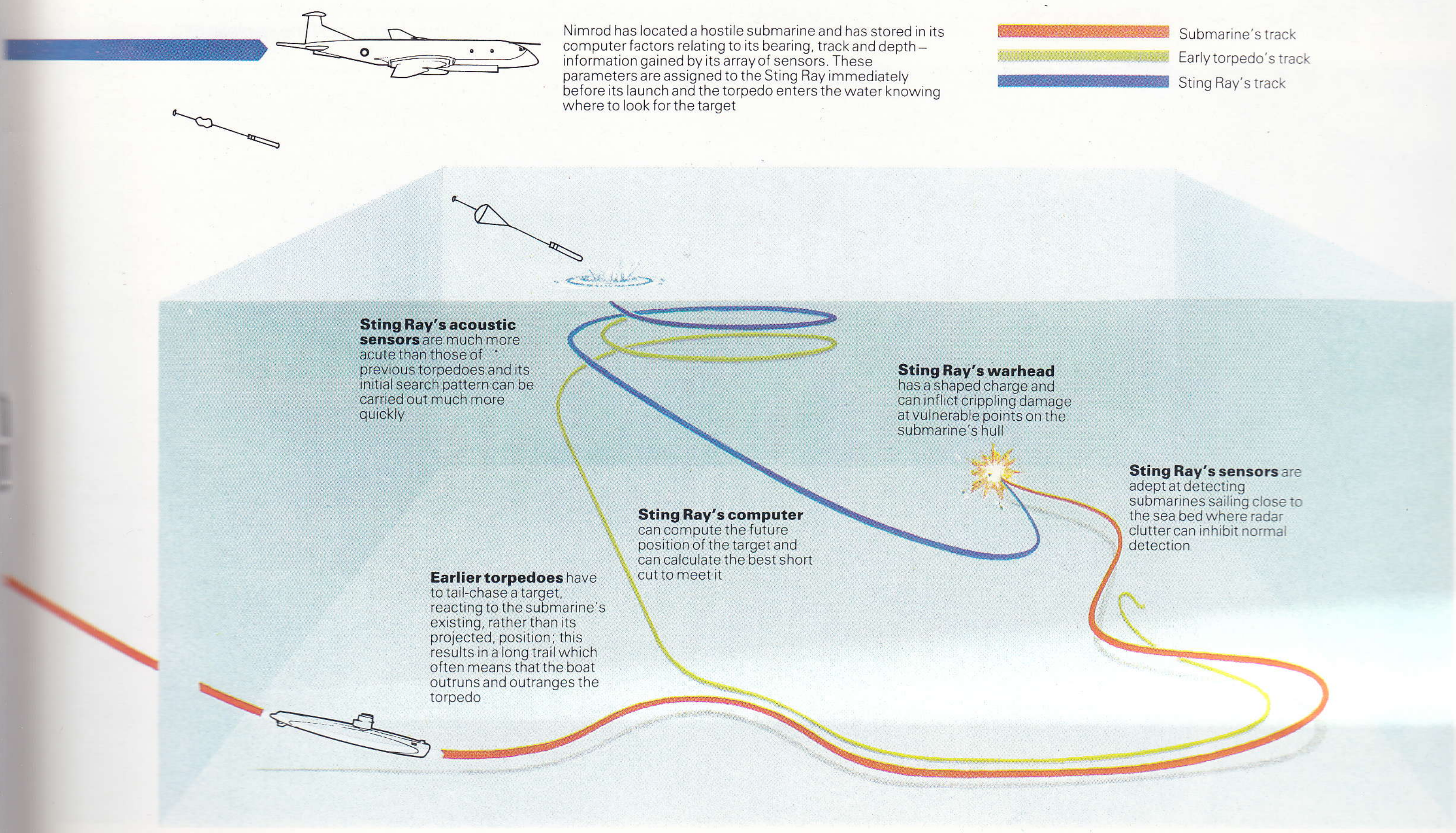


The guidance system of modern torpedoes is fragile enough to require parachute retardation when launched from fast-moving aircraft such as the British Aerospace Nimrod.



Stingray's onboard computer will have been fed target data up until the moment of launch, and upon entry to the water will discard the drogue parachute and begin to seek the target with its own sonar.

Sting Ray attack



Nimrod has located a hostile submarine and has stored in its computer factors relating to its bearing, track and depth – information gained by its array of sensors. These parameters are assigned to the Sting Ray immediately before its launch and the torpedo enters the water knowing where to look for the target

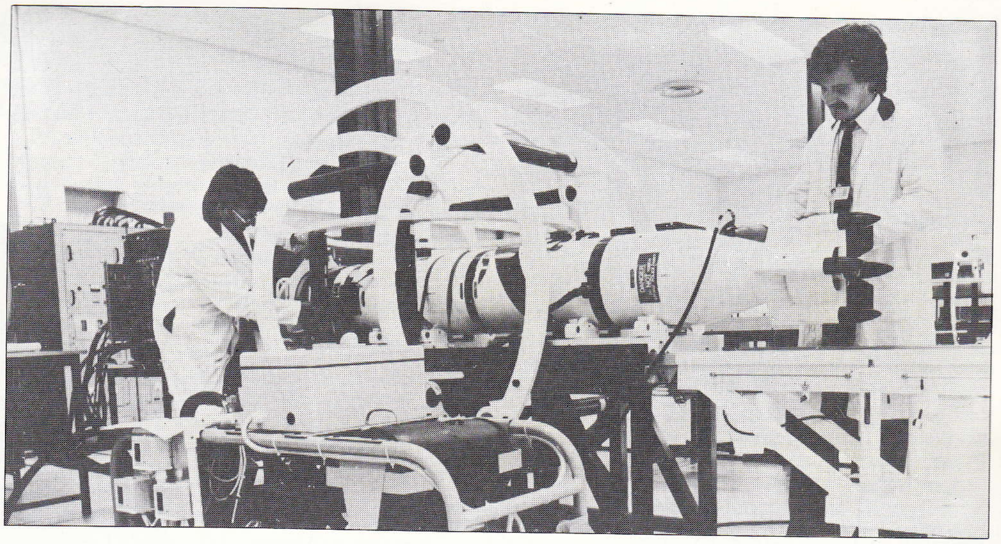
Sting Ray's acoustic sensors are much more acute than those of previous torpedoes and its initial search pattern can be carried out much more quickly

Sting Ray's warhead has a shaped charge and can inflict crippling damage at vulnerable points on the submarine's hull

Sting Ray's sensors are adept at detecting submarines sailing close to the sea bed where radar clutter can inhibit normal detection

Sting Ray's computer can compute the future position of the target and can calculate the best short cut to meet it

Earlier torpedoes have to tail-chase a target, reacting to the submarine's existing, rather than its projected, position; this results in a long trail which often means that the boat outruns and outranges the torpedo



Stingray undergoes tests at the new production line built by Marconi for the project. The cost of the programme has been considerably more than first estimated; staying in the van of advanced weapon technology is not cheap.

as a result of the pressure) or to force it to come to the surface (where the ship's other weapons could sink it).

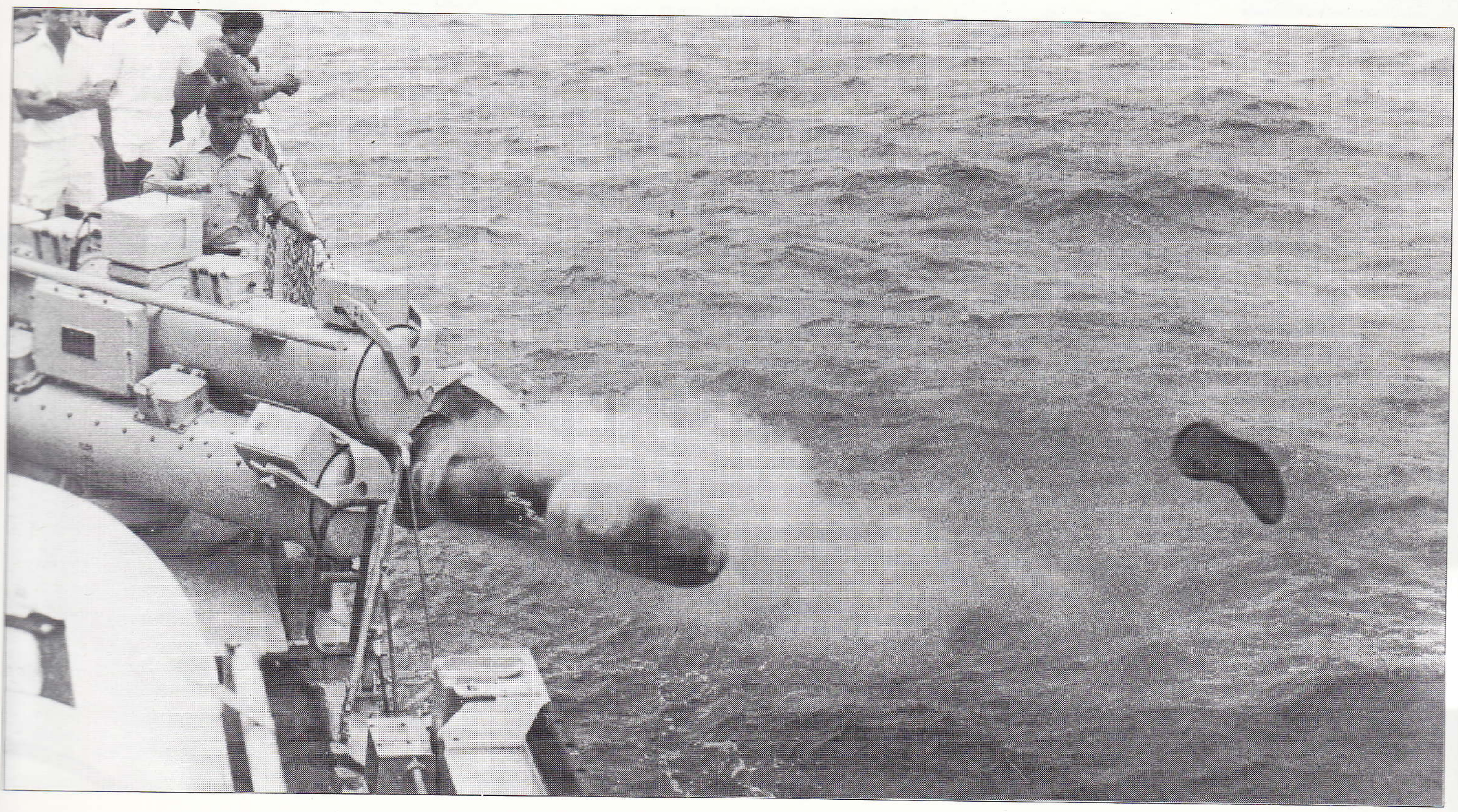
In the airborne launch application the initial detection of the target is usually dependent on either the host platform's sensors (such as passive/active sonobuoys and active dipping sonar) or the vectoring in of the platform via information derived from external sources such as a ship's towed-array or active sonar sets. Final target localization is usually effected by a magnetic anomaly detection (MAD) system and, if time permits, the marking of the weapon drop datum point by a smoke or flare pot. Once the spot is identified a parachute-retarded Stingray is released to enter the water. Once submerged it starts on a preprogrammed search pattern designed to optimize the chances of acquiring the target. When acquisition has taken place, the ability of Stingray's computer to anticipate the target's movements comes into its own by effectively minimizing the time spent on manoeuvring after the target and thus giving itself a greater chance to close and hit it during the battery's lifetime of some eight minutes or so.

Little combat use

Although fully operational weapons were taken south by several ships during the 1982 Falklands war, no Stingrays were fired in anger. Only the Mk 46 Mod 2 was used under combat conditions, the first being dropped on 25 April 1982 by HMS *Brilliant*'s Lynx HAS.Mk 2 off South Georgia during the combined helicopter operations against the surfaced Argentine submarine *Santa Fe* by a Westland Wessex HAS.Mk 3 equipped with depth charges, the Lynx and several Westland Wasp HAS.Mk 1s fitted with AS.12 wire-guided missiles. Further Mk 46s were dropped by Sea King helicopters and others were fired from ships' STWS-1 systems during a number of submarine scares throughout the war, but as far as can be ascertained these torpedoes hit nothing save a frigate's Type 182 towed noisemaker decoy on one occasion and, if the reports are to be believed, several unfortunate whales which just happened to be in the wrong place at the wrong time. If Stingrays had been used instead of the Mk 46s, practically all these 'false' target hits would not have occurred and the *Santa Fe* would have certainly added considerable torpedo damage to its list of woes inflicted by the helicopters; she may possibly not have reached the safety of Grytviken harbour.

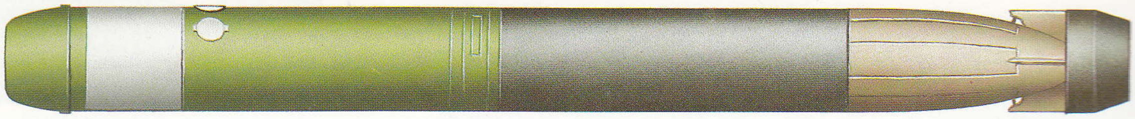
For the future is likely that the American suggestion for engining Stingray with a new propulsion plant (to increase its maximum underwater speed to match that of the new Soviet submarine classes) will be followed. However, like all defence matters today this will depend on whether or not the cash can be found to do it and (now more important) whether or not there is the political will to implement such modification as higher-cost projects cream off available financial assets. Failing such a development, Stingray will probably end up as yet another British success story for the other side.

A Stingray is launched from a frigate of the Royal Navy. Although primarily an air-launched weapon, the Kingfisher system has been developed to allow tube launch from surface vessels.



UK

Marconi Mk 24 Tigerfish torpedo



The end result of an unbelievably protracted development programme, the Tigerfish wire-guided heavyweight torpedo is a development of the Mk 24 torpedo, having a maximum speed variously estimated at 35 or 50 kts and a maximum range at low speed of some 21 km (13 miles).

The origins of the **Mk 24 Tigerfish** heavyweight torpedo saga can be found as far back as 1959 in a British torpedo project codenamed 'Ongar'. By 1970 it was realized that the technology involved could not be handled solely by an in-house service approach, so the then Marconi Company was given the job of developing the weapon from 1972 onwards. This was five years after the originally envisaged in-service date. As a result of development and engineering problems the first version of the Tigerfish, the **Mk 24 Mod 0**, entered fleet service in 1974 with less operational capability than originally desired. It was only granted its full Fleet Weapon Acceptance certificate in 1979 after protracted evaluation.

To rectify the problems Marconi initiated development of a product-improved version, the **Mk 24 Mod 1**, during 1972 but this also encountered technical problems and finally entered limited service in mid-1978. By 1981 sufficient update kits were available to upgrade all the earlier Mod 0 weapons to this standard. Designed for submarine use against submerged (Mod 0 and 1) and surface (Mod 1) targets, the dual-speed electric-powered Tigerfish is guided in its initial stage by wire dispensed from both the submarine and the torpedo itself, using data derived from the launch platform's passive sonar sets. The roll-stabilized (by retractable mid-body stub wings) torpedo is guided in this fashion up to the point where its own three-dimensional active/passive sonar seeker head and computer can take over for the attack on the target. At present only the Royal and Brazilian navies use the Tigerfish. A further programme is under way to examine possible enhancements to the weapon's capabilities with a view to countering the new generation of Soviet nuclear submarines.

Specification

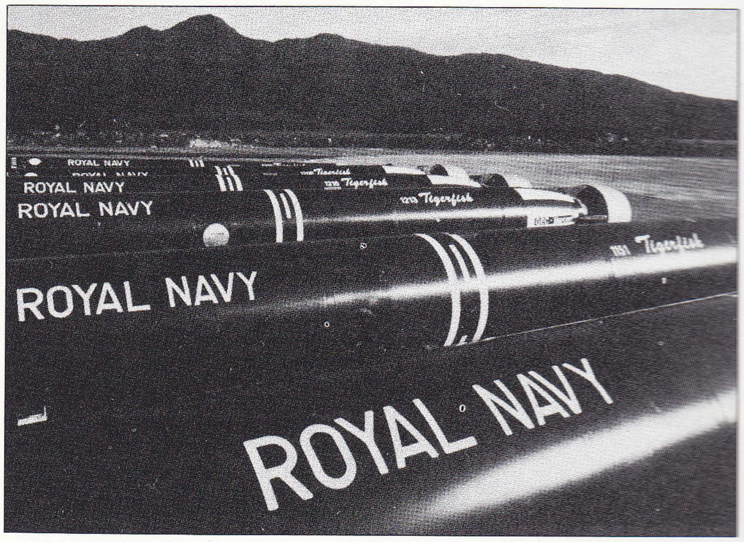
Mk 24 Tigerfish

Dimensions: diameter 533 mm (21 in); length 6.464 m (21.2 ft)

Weight: 1547 kg (3,410 lb)

Warhead: 134-kg (295-lb) HE

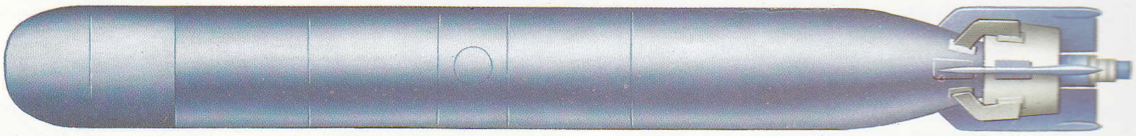
Performance: speed 24 or 35 kts; range 21 or 13 km (13.05 or 8.08 miles)



The Tigerfish is propelled by a two-speed electric motor driving a pair of contra-rotating propellers designed for high efficiency and low noise production. The 134-kg (295-lb) high-explosive warhead can be detonated by contact or by proximity fusing.

UK

Marconi Spearfish torpedo



Externally very similar to the Mk 24 Tigerfish wire-guided torpedo that it will eventually replace, the Marconi Spearfish is radically different internally and has a considerably enhanced performance.

Designed to meet Naval Staff Requirement 7525, the **Marconi Spearfish** is an advanced-capabilities wire-guided dual-role (ASW/anti-ship) heavyweight torpedo. It will be able to engage the new generation of Soviet high-speed deep-submergence submarines using a new HAP-Otto fuel-powered Sundstrand 21TP01 gas turbine engine with a pump-jet outlet to achieve speeds in excess of 60 kts (up to 70 kts on trials). The warhead is of the directed-energy shaped-charge type and is capable of penetrating the latest Soviet developments in submarine double-hull construction which can be found aboard the 'Oscar' SSGN and 'Typhoon' SSBN classes. To ensure that the weapon actually contacts the target's hull the installed guidance system uses technology developed originally for the Stingray lightweight torpedo project. The computer will enable the torpedo to make its own tactical decisions during an engagement, optimizing the homing modes available to the underwater environment encountered and to the target's use of decoys and manoeuvring patterns.

Work on the development prototypes began in 1982, the first in-water trials taking place in the following year. Production deliveries are believed to be due in 1987, with operational capability scheduled for 1988-9.

Specification (provisional)

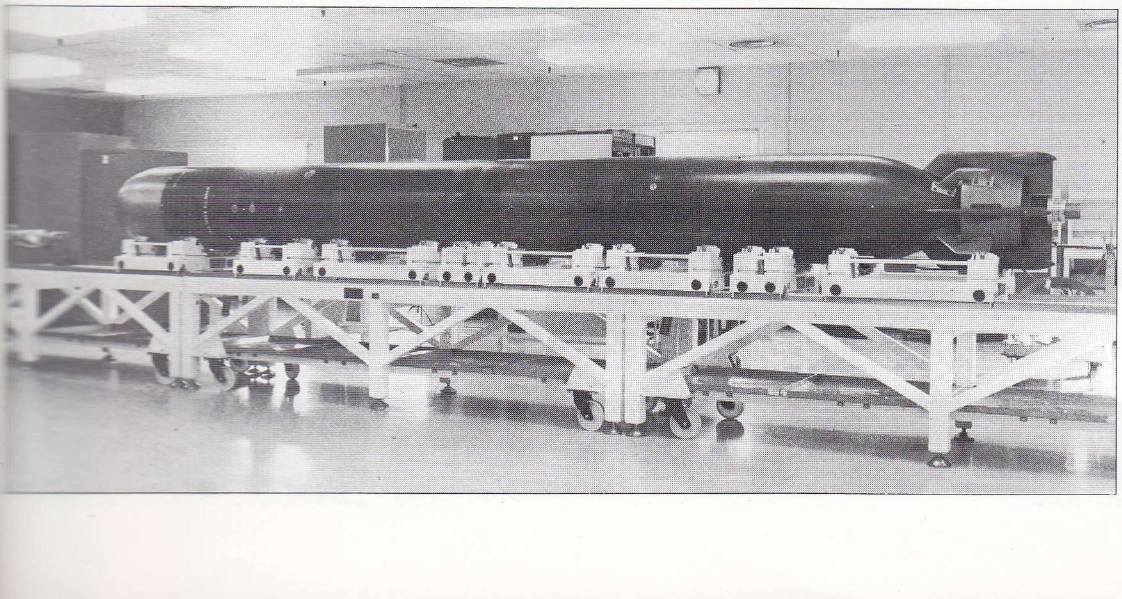
Spearfish

Dimensions: diameter 533 mm (21 in); length 8.5 m (27.9 ft)

Weight: 1996 kg (4,400 lb)

Warhead: 249-kg (550-lb) HE

Performance: speed 24 or 60 kts; range 46.25 or 28.6 km (28.75 or 17.75 miles)



Above: An early development model of the Spearfish is seen at the start of water trials. The torpedo guidance system is thought to make use of a digital computer (as in the Stingray), and the highly classified directed energy warhead is designed to cope with the latest Soviet submarines.

Left: Powered by an HAP-Otto fuelled gas turbine giving considerably more power density than electric motors, the Spearfish has achieved great speeds on trials, reaching more than 60 kts.

SWEDEN

FFV Tp42 series torpedoes

Originally intended as the successor to the Royal Swedish navy's Tp41, the **Tp42** is the base model of a whole series of lightweight 400-mm (15.75-in) torpedoes built by FFV for the home market and for export. The basic model, the **Tp422**, entered service in mid-1983 and is intended primarily for ASW operations from the navy's small fleet of Boeing-Vertol 107 helicopters. It is unique amongst Western lightweight weapons in that it is capable of wire guidance after an air-launched delivery. The terminal attack phase is carried out by a passive sonar system. Propulsion is by an electric battery of the silver-zinc type, whilst the warhead is fitted with both proximity and contact fuses. The torpedo can be set to run at one of two speeds which are changeable after launch either via the guidance wire or as an instruction pre-programmed into the seeker unit. A similar model, the **Tp423**, is believed to be intended for launch from surface ships and submarines against submarine or ship targets. The export version of the Tp422/423 is known as the **Tp427**, and has internal/guidance changes which effectively introduce different sonar and proximity fuse frequencies in order not to compromise Swedish navy settings.

In 1984 the Swedish navy initiated a product improvement programme that has resulted in the **Tp432**, which is due to enter production in 1987. This is designed to use new digital microprocessor guidance units and is optimized to attack the new generation of Soviet conventional submarines operating in the quiet state in shallow waters. A new three-speed selectable propulsion system and increased guidance wire capacity have improved the maximum range of the weapon, at the slowest speed, by 33 per cent in comparison with the earlier Tp42 models. The equivalent export version is designated **Tp43XO** and will be able to use alternative propulsion systems if required. The lightest of the whole Tp432/43XO family will be the helicopter-launched variant which weighs 280 kg (617 lb), and because it has a smaller battery capacity this will have a maximum range in the order of 15-20 km (9.3-12.4 miles) at the slowest speed setting.

Specification
Tp422/427

Dimensions: diameter 400 mm (15.75 in); length 2.44 m (8.00 ft), or 2.60 m (8.53 ft) with wire guidance section

Weight: 298 kg (657 lb)

Warhead: 45-kg (99-lb) HE

Performance: speed 15 or 25 kts; range 20 or 10 km (12.43 or 6.21 miles)

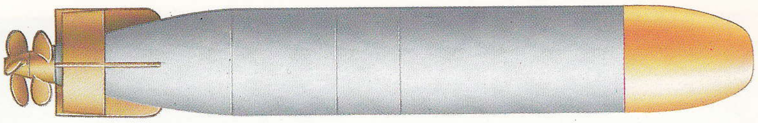
Specification
Tp432/43XO

Dimensions: diameter 400 mm (15.75 in); length 2.60 m (8.53 ft), or 2.85 m (9.35 ft) with wire guidance section

Weight: 280 to 350 kg (617 to 772 lb)

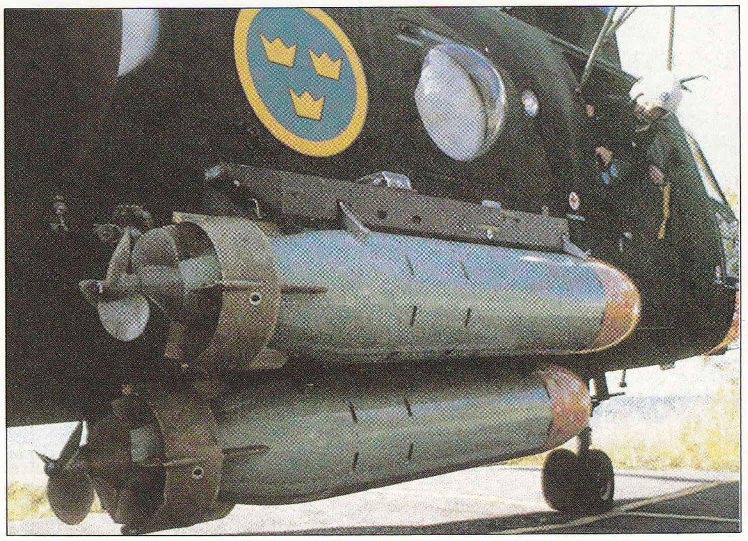
Warhead: 45-kg (99-lb) HE

Performance: speed 15, 25 or 35 kts; range 30, 20 or 10 km (18.64, 12.43 or 6.21 miles)



Above: The Type 42 range of lightweight 400-mm (15.75-in) torpedoes is the only air-launched torpedo known to be wire-guided. It can be controlled by a hovering or cruising helicopter, although a variant has been designed for surface or submarine use. The Type 427 export version is illustrated.

Below: The advantage of lightweight torpedoes is that they can give a significant anti-submarine capability to the smallest of helicopters. The Type 422 has been launched from the Swedish navy's AB-406 helicopters, although the KV 107 (licence-built Boeing-Vertol CH-46) is the usual platform.

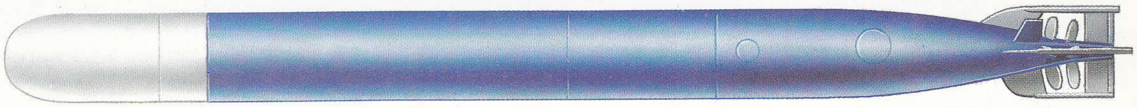


SWEDEN

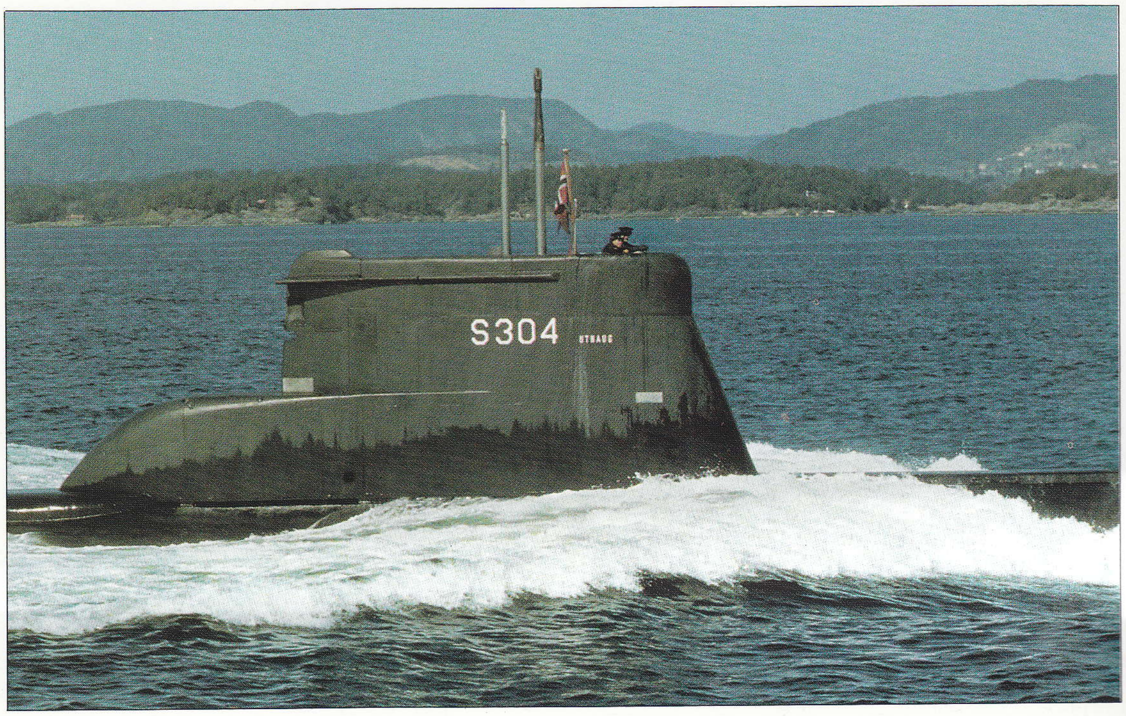
FFV Tp61 series torpedoes

Designed by FFV for use against surface ship targets, the **Tp61** entered service in 1967 as a non-terminal-homing wire-guided heavyweight torpedo for use by surface ships, submarines and coastal defence batteries. In 1984 the longer-range **Tp613** entered service as the Tp61's successor with essentially the same propulsion system and a terminal homing seeker that utilizes an onboard computer to oversee the attack and, if necessary, to initiate previously-programmed search patterns at the target's predicted location. The computer also guides the torpedo to the latter point and initiates a search even if the guidance wire is broken. The torpedo's thermal propulsion system combines hydrogen peroxide with ethanol to power a 12-cylinder steam motor which produces an almost invisible wake signature. Compared with modern electrically-powered weapons at similar speed, the maximum range attainable is between three and five times greater.

The earlier Tp61 is in service with Norway, whilst the Tp613 has recently been ordered by Denmark. Norway is also expected to purchase this variant in the near future. For other nations there is the **Tp617** export version which differs from the Tp613 only in



Unlike most modern heavyweight torpedoes, the FFV Tp61 is not powered electrically but by a hydrogen-peroxide/ ethanol driven engine. Such systems are more unstable than battery power, but of much higher performance.



Norway is in the process of acquiring the improved Tp613 torpedo in place of the Tp61 already operated. The new weapon will probably equip the 'Type 207' submarines such as Uthaug, seen here, as well as the new 'Type 210' class which will enter service in the 1990s.

internal software changes to give sonar and proximity fuse settings different from Swedish ones. Each Tp61 series torpedo can be left in its tube for up to four months without requiring overhaul.

Specification
Tp61
Dimensions: diameter 533 mm (21 in); length 7.025 m (23.05 ft)
Weight: 1796 kg (3,959 lb) or (Tp613) 1850 kg (4,078 lb)
Warhead: 250-kg (551-lb) HE
Performance: speed 45 kts; range 20 km (1.43 miles) or (Tp613) 30 km (18.64 miles)

Snar, a 'Snogg' class fast attack craft, is fitted with four 533-mm (21-in) torpedo tubes in addition to Penguin anti-ship missiles. The torpedo and the missile have similar ranges and although the missile is much faster the torpedo does not appear on any radar screen.

USA

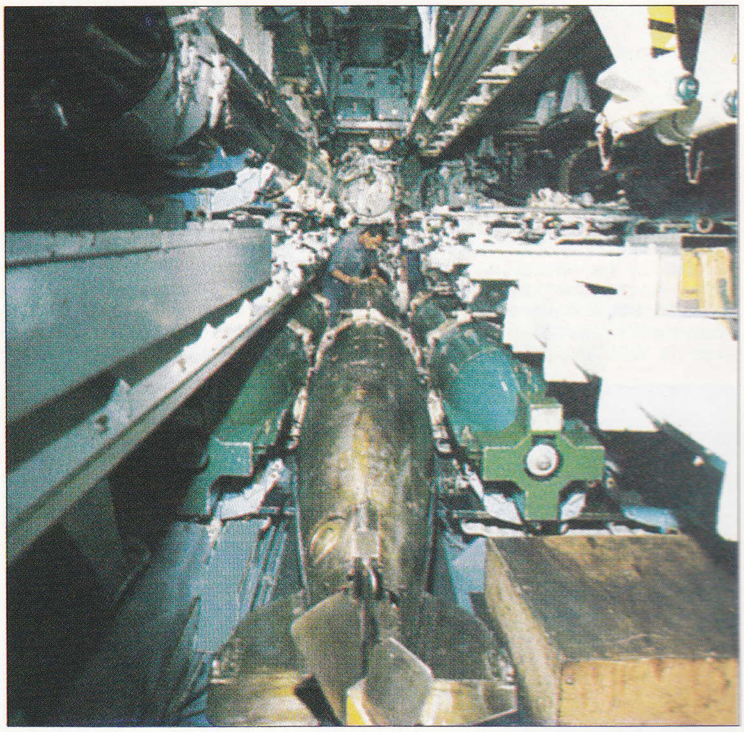
Mk 37 torpedo

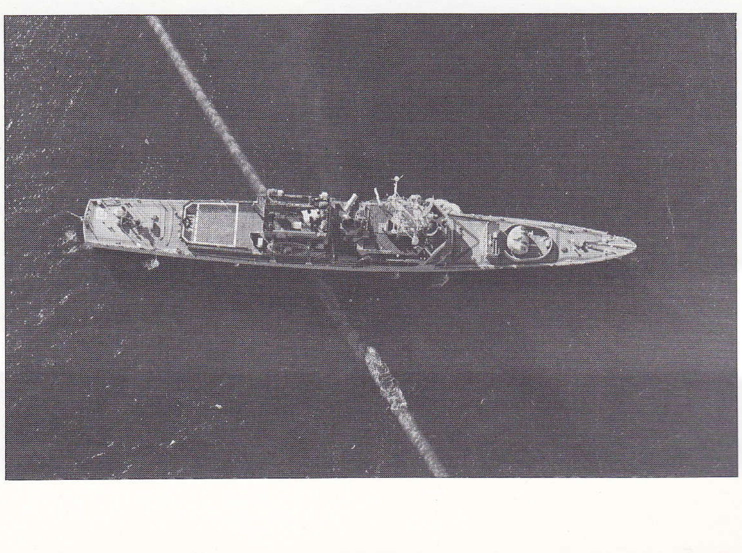
The original **Westinghouse Mk 37 Mod 0** heavyweight torpedo entered service in 1956 as a submarine- and surface ship-launched ASW acoustic-homing free-running torpedo. Fitted with studs along its sides, the 482.6-mm (19-in) calibre Mk 37 can be fired from standard 533-mm (21-in) torpedo tubes. As operational experience built up with the weapon, many Mod 0 torpedoes were refurbished and modified to bring them up to the **Mk 37 Mod 3** standard. Although useful in the ASW role these free-running weapons, which could dive to 300 m (985 ft), were not suited to really long sonar detection ranges as during the torpedo's run to a predicted target location it was possible that the target could perform evasive manoeuvres taking it out of the 640 m (2,100-ft) acquisition range of the weapon's seeker head. Thus wire guidance was fitted to the Mk 37 to produce the **Mk 37 Mod 1** version, which entered service in 1962 aboard American submarines. This was followed by the updated **Mk 37 Mod 2** conversion of Mod 1 weapons. Although the standard US Navy submarine-launched ASW torpedo for some 20 years, the Mk 37 is now found only aboard the diesel-electric boat USS *Darter*.

Many have been converted to Mk 67 submarine-launched mobile mine shells, whilst others have been put through major upgrading programmes before sale to other countries. The first such modification, in the mid-1970s, resulted in the **Northrop NT37C**, which incorporates a new thermo-chemical propulsion system based on that of the Mk 46 and has an anti-ship capability option. The NT37C is known to be in service with Canada and Israel aboard their submarine fleets. In 1979 Honeywell acquired the rights to the NT37C, and at the request of several NATO Mk 37 users further developed the weapon to the **Honeywell NT37E** standard which allows the fitting of several additional kits to produce **NT37E Mod 2** and **NT37E Mod 3** conversions of the basic Mk 37 variants. In general terms these new variants display a 40 per cent increase in speed, a 150 per cent increase in range, an 80 per cent increase in endurance and a 100 per cent increase in seeker detection range in comparison with the original Mk 37 models. At least 16 countries are known to use the various versions of the Mk 37 family including the above, plus West Germany, Spain, Argentina and the Netherlands.

Specification
Mk 37
Dimensions: diameter 484.6 mm (19 in); length (Mod 0 and 3) 3.52 m (11.55 ft) or (Mod 1 and 2) 4.09 m (13.42 ft)
Weight: (Mod 0 and 3) 649 kg (1,430 lb) or (Mod 1 and 2) 767 kg (1,690 lb)
Warhead: 150-kg (330-lb) HE
Performance: speed 16 or 24 kts; range (Mod 0 and 3) 16.5 or 7.3 km (10.25 or 4.5 miles), or (Mod 1 and 2) 8.7 km (5.4 miles)

Specification
NT37E
Dimensions: diameter 484.6 mm (19 in); length (Mod 2) 4.506 m (14.78 ft) or (Mod 3) 3,946 m (12.62 ft)
Weight: (Mod 2) 748 kg (1,650 lb) or (Mod 3) 640 kg (1,412 lb)
Warhead: 150-kg (330-lb) HE
Performance: speed 22.4 or 33.6 kts; range (Mod 2) 21.7 km (13.5 miles) or (Mod 3) 18.3 km (11.4 miles)



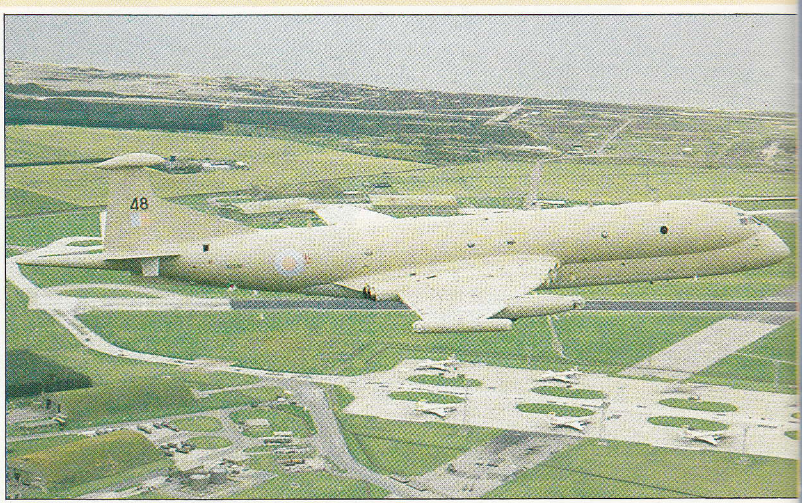


Above: Dutch seamen manoeuvre the long, heavy bulk of a NATO standard NT37 torpedo into one of the forward tubes of a 'Dolfijn' class submarine. The original Mk 37 entered service in the 1950s, but progressive modifications by Westinghouse and Northrop have upgraded the weapon's capability to an enormous extent.

Left: In its anti-ship version the NT37 can be programmed to explode on contact or be fitted with an acoustic proximity fuse. By adjusting the running depth this can ensure detonation immediately under the target, so breaking the ship's back. Had the trial torpedo seen here been armed, the explosion would have occurred immediately under the engines.

Nuclear Weapons at Sea

The proliferation of nuclear weaponry has seen widespread deployment of nuclear anti-ship and anti-submarine weaponry at sea. Such are the defences of a modern Carrier Battle Group that a nuclear attack may be the only feasible method of attack, and the temptation to use a nuclear weapon to disrupt a submarine attack could well prove irresistible.



A British Aerospace Nimrod sets out from its base at Kinloss on the first leg of one of its long North Atlantic patrols. The Nimrods are equipped to carry two 5-10 kt yield B-57 weapons, but would only be so armed if the threat of war was overwhelming.

It may be surprising to some that in any future war between NATO and the Warsaw Pact the first use of tactical weapons with low kiloton yields will probably occur at sea as an integral part of a fiercely-fought ASW battle for the North Atlantic and its surrounding sea areas. Although a large number of the NATO nations contribute naval forces to NATO's Atlantic command structure, only the UK's Royal Air Force and Royal Navy, the Royal Netherlands air force and the US Navy are fully trained in the operational use of the 5/10-kiloton yield B57 nuclear depth bomb.

In a recent political move the Dutch have made the decision to withdraw the B57 capability from their Lockheed Orion force, each of whose 13 P-3Cs can carry two such bombs.

In the UK the B57 bombs are held in nuclear weapon stores for wartime use by the RAF's four squadrons and an OCU flying 31 BAe Nimrod MR.Mk 2s (two bombs each) and the Royal Navy's seven front-line and training squadrons equipped with 64 ASW and 22 training Westland Sea King HAS.Mk 2A/5s (one bomb each). The Sea Kings plus the three front-line and training squadrons with 49 ASW/anti-ship and 11 training Westland Lynx HAS.Mk 2/3s (one bomb each) and a rapidly declining number of Westland Wasp HAS.Mk 1s (one bomb each) also use the smaller 1-kiloton yield variant of the UK's own indigenous tactical nuclear gravity bomb, the Green Parrot.

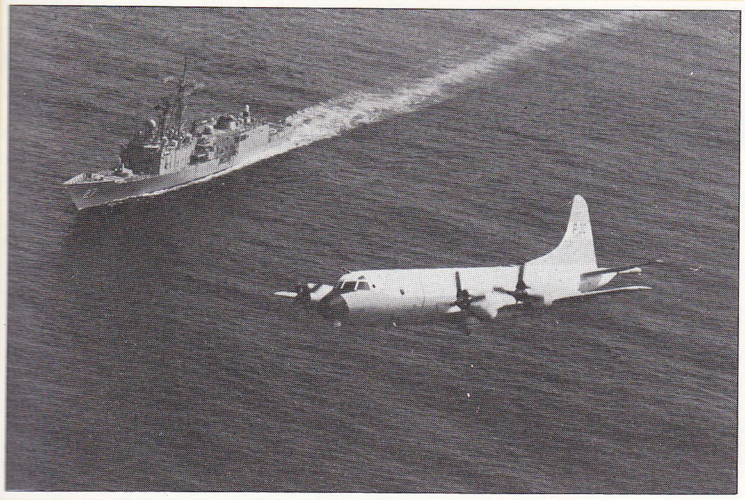
The main US Navy aerial nuclear ASW delivery platforms are the 24 active and 13 reserve squadrons (nine aircraft each) of Lockheed P-3 Orions. These are backed by 11 carrier and one shore-based squadrons (10 aircraft each) of Lockheed S-3A Viking (one bomb each) ASW jets, and 12 carrier and two shore-squadrons (six aircraft each) of Sikorsky SH-3H Sea King (one bomb each) ASW helicopters. The replacement for the Sea King, the Sikorsky SH-60B Seahawk, is also tasked to carry the B57 or its successor.

Nuclear ASW

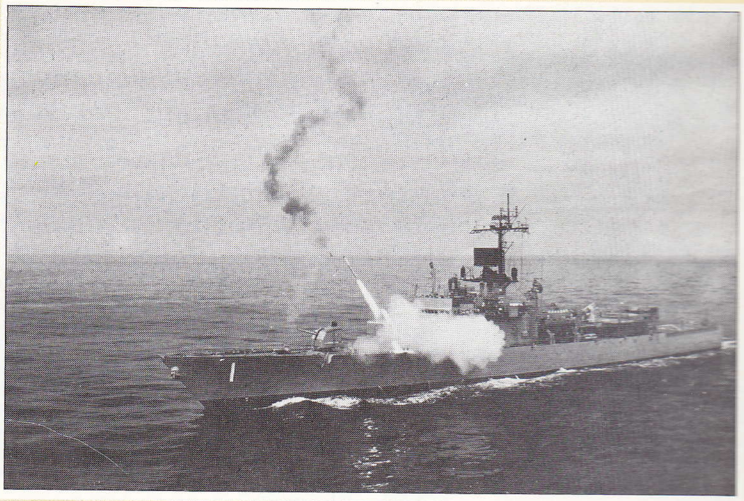
Aboard NATO surface ships nuclear ASW weaponry is limited solely to US Navy ships, which are equipped to carry and fire the RUR-5A ASROC missile fitted with the 1.5-kiloton yield W44 warhead in a Mk 17 nuclear depth charge housing. Over 65 frigates, 78 destroyers and 27 cruisers have been made nuclear-capable with this weapon system. In the long term the RUR-5A is to be replaced by the Vertical Launch ASROC, which has a much longer engagement range. Aboard submarines the Mk 45 ASTOR wire-guided anti-ship torpedo (10-kiloton W34 warhead) has been completely replaced by the conventional-warhead Mk 48, leaving the UUM-44A SUBROC underwater-launched missile with its W55 low-yield warhead as the only tactical ASW nuclear weapon available to American submarines. Some 50 nuclear attack submarines are currently equipped to carry and launch this obsolescent weapon, but the numbers are declining slowly as non-compatible digital fire-control systems are fitted in place of the earlier analog systems; cruise missiles are thus being carried instead of SUBROCs. A new long-range ASW Stand-Off Weapon is under development for submarine use in the late 1980s. Contrary to some reports about the Royal Navy, no other NATO navy uses either ship- or submarine-launched nuclear warhead-equipped ASW weapons of the types just described.

In a similar way only the Soviet navy amongst the navies of the Warsaw Pact has been equipped with any nuclear ASW weapons: since the 1950s a wide variety of tactical nuclear delivery systems has been developed for all operational branches of the Soviet navy. For aircraft use a 10/15-kiloton yield nuclear depth bomb is carried by the Soviet naval air force's force of 55 Tupolev Tu-142 'Bear-F' (two bombs each) long-range, 50 Ilyushin Il-38 'May' (two bombs each)

In October 1981 the Soviet navy suffered the embarrassment of a 'Whiskey' class submarine being left high and dry while on a clandestine mission into Swedish waters. Radiation monitors detected nuclear weapons aboard the vessel, most probably as the warheads of torpedoes.



The main US nuclear delivery platform at sea is the force of more than 400 P-3 Orions equipping 37 front-line and reserve squadrons of the US Navy. This is the latest version, the P-3C Update III, seen over the 'Oliver Hazard Perry' class frigate USS Mahlon S. Tisdale.



An ASROC missile is launched from the guided missile frigate USS Brooke *(FFG-1). Only the US Navy operates nuclear-tipped ASROC, with more than 170 surface combatants capable of firing the single-kiloton depth charge version of the missile.*

medium-range and 90-odd Beriev M-12 'Mail' (one bomb each) short-range ASW aircraft, together with a fairly large proportion of the 90 Mil Mi-14 'Haze-A' (one bomb each), 120 Kamov Ka-25 'Hormone-A' (one bomb each) and 50 plus Kamov Ka-27 'Helix-A' (one bomb each) ASW helicopters available. The 'Hormones' and 'Helixes' are used both from shore bases and afloat on aviation ships, cruisers and destroyers.

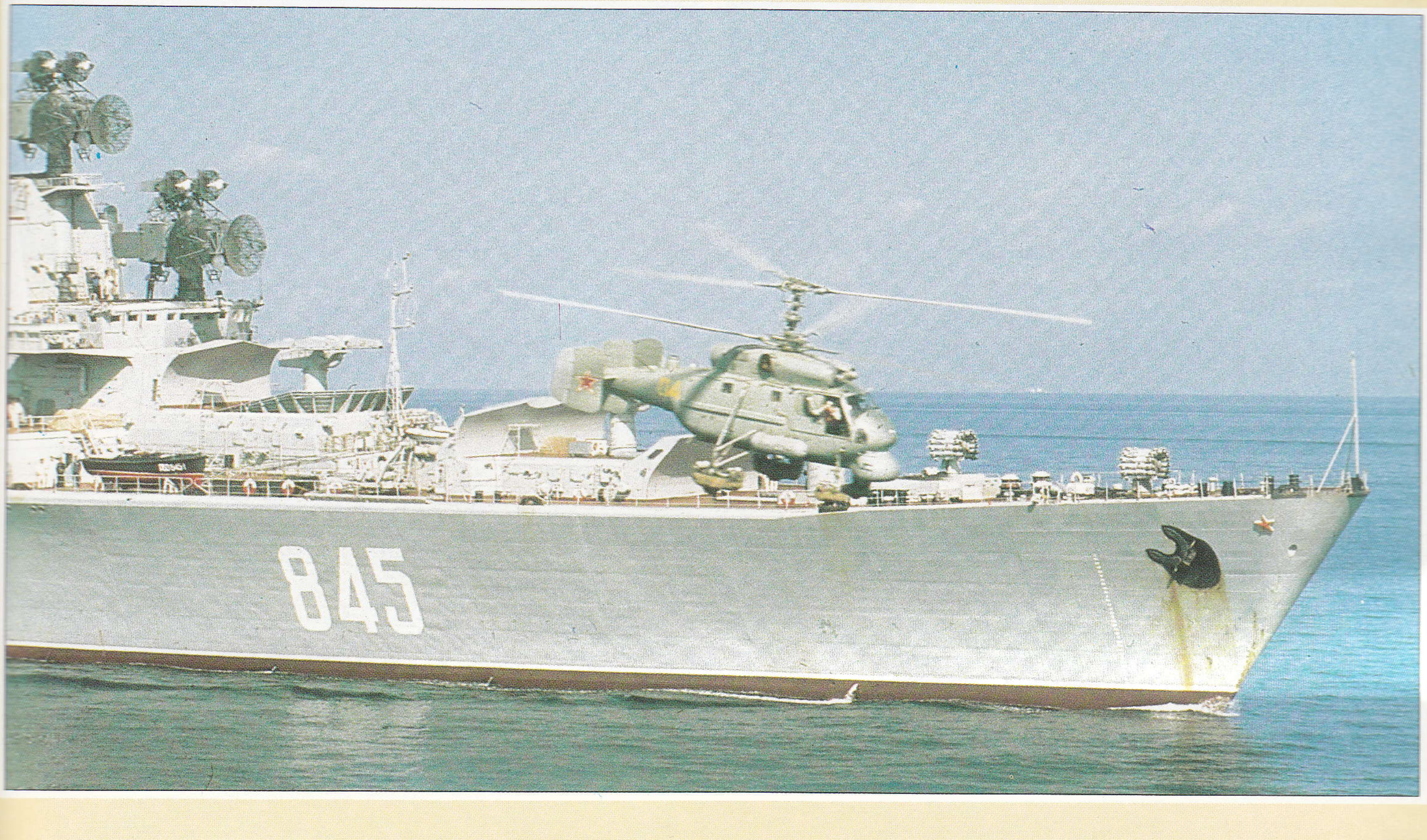
Surface weapons

For surface ship use only the 'Kiev' and 'Moskva' class aviation ships use an ASROC type weapon, the SUW-N-1 system with its FRAS-1 rocket equipped with a nuclear depth charge. Other surface ships use the SS-N-14 'Silex' ASW missile, which has a homing torpedo with conventional warhead as its payload.

In contrast the Soviet submarine force is well endowed with tactical nuclear weapons. Leaving aside cruise and ballistic missiles, most conventional and nuclear submarines include as part of their torpedo outfit some two to four 533-mm (21-in) calibre anti-ship torpedoes equipped with 15-kiloton yield nuclear warheads; these torpedoes can also be used in the area-target ASW role. In fact just such a torpedo was the first Soviet naval nuclear weapon tasked, in the mid-1950s and early 1960s, with the anti-carrier and anti-port roles. As recently as October 1981, with the fiasco of the Soviet 'Whiskey' class conventional submarine aground on rocks in restricted Swedish coastal waters, it was found by radiation-monitoring techniques that the boat had such weapons aboard: this shows the widespread use of these weapons in the Soviet fleet. To back the torpedoes and to provide a long-range ASW weapon, the Soviets introduced aboard several of their nuclear attack and cruise missile submarines in the early 1970s their own version of the SUBROC, designated SS-N-15 by NATO. Fired from standard 533-mm (21-in) calibre torpedo tubes, the SS-N-15 uses range and bearing data derived from the launch platform's own sonars to deliver a 15-kiloton yield nuclear depth bomb to the immediate vicinity of the target.

In additon to these nuclear weapons, both sides could if required call on their respective strategic ICBM forces for limited numbers of comparatively high-yield weapons to sanitize large ocean areas of all underwater vehicles. This option would, however, only be used in a full-scale war, for such a detonation would also destroy any friendly units in the area.

A Kamov Ka-25 'Hormone' moves along the bows of the Soviet helicopter ASW cruiser Moskva. *The helicopter is probably capable of carrying a nuclear depth bomb, and the cruiser fires the nuclear FRAS-1 rocket.*



USA

Mk 44, Mk 46 and Mk 50 torpedoes

The **Mk 44 Mod 0** lightweight torpedo was selected for production in 1956 and in the following year became the payload for the new ASROC ASW missile as well as the standard US Navy ship- and air-launched lightweight torpedo. The weapon is electrically powered, and utilizes a seawater-activated battery and an active-homing seeker with a detection range of 585 m (1,920 ft). A slightly modified version, the **Mk 44 Mod 1**, was produced at a latter date, and this model differed only in internal details. Several countries procured the weapon, but most have now replaced it with the Mk 46 although some like the UK have kept stocks because of the Mk 44's better shallow-water performance than its successor. The US Navy replaced it completely from 1967 onwards by the **Mk 46**.

The active/passive acoustic-homing Mk 46 programme began in 1960, the first production rounds of the air-launched **Mk 46 Mod 0** variant being delivered in 1963. The new torpedo achieved twice the range of the Mk 44, could dive deeper (460 m/1,500 ft versus 300 m/984 ft) and was 50 per cent faster (45 kts versus 30 kts) because of the use of a new type of propulsive system. In the Mod 0 this was a solid-fuel motor, but as a result of maintenance difficulties it had to be changed to the Otto-fuelled thermo-chemical cam engine in the follow-on **Mk 46 Mod 1** (which first entered service in 1967 for use in ASROC, surface ship and some airborne launching purposes) and the **Mk 46 Mod 2** that first appeared in 1972. There was no Mod 3, so the next variant to see service was the **Mk 46 Mod 4** intended specifically for use as the payload for Mk 60 CAPTOR mines. However, because of Soviet submarine developments (primarily in the area of anechoic hull coatings to degrade active sonar acoustic transmissions) the US Navy had to develop a modfication kit with new guidance and control units, engine improvements and an enhanced sonar transducer to restore the 33 per cent loss in the 550-m (1,800-ft) detection range suffered by Mk 46s when encountering such coatings. Known by the title **NEARTIP** (NEAR-Term Improvement Program), the **Mk 46 Mod 5** is being procured both as new-build weapons and as conversions of the earlier Mod 1 and Mod 2 weapons.

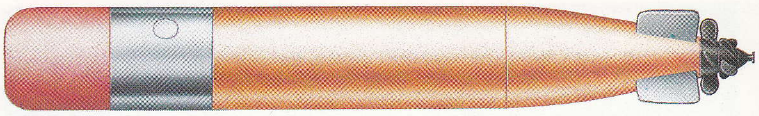
Apart from the US Navy, other users of the Mk 46 include Australia, Brazil, Canada, France, Greece, Indonesia, Iran, Israel, Italy, Morocco, the Netherlands, New Zealand, Pakistan, Saudi Arabia, Spain, Turkey, Taiwan, the UK and West Germany. The Mk 46 was used operationally by the Royal Navy on a number of occasions during the Falklands war with inconclusive results, although the threat of Mk 46s did help in the damaging and subsequent grounding of the Argentine submarine *Santa Fe* off South Georgia.

The replacement for the Mk 46 in US Navy service is the **Advanced Lightweight Torpedo (ALWT)**, which has now been given the designation **Mk 50 Barracuda** following a competitive evaluation. Fitted with a directed-energy shaped-charge warhead, the Mk 50 is roughly the same size and weight as the Mk 46 but will be faster at 55+ kts and be able to dive deeper (to 600 m/1,970 ft). It will also have a new stored chemical-energy propulsion system with a closed-cycle steam turbine in conjunction with a pump-jet arrangement. An onboard computer and advanced active/passive sonar will give the weapon 'smart' capabilities similar to those of the British Stingray. An in-service date of 1990 is anticipated.

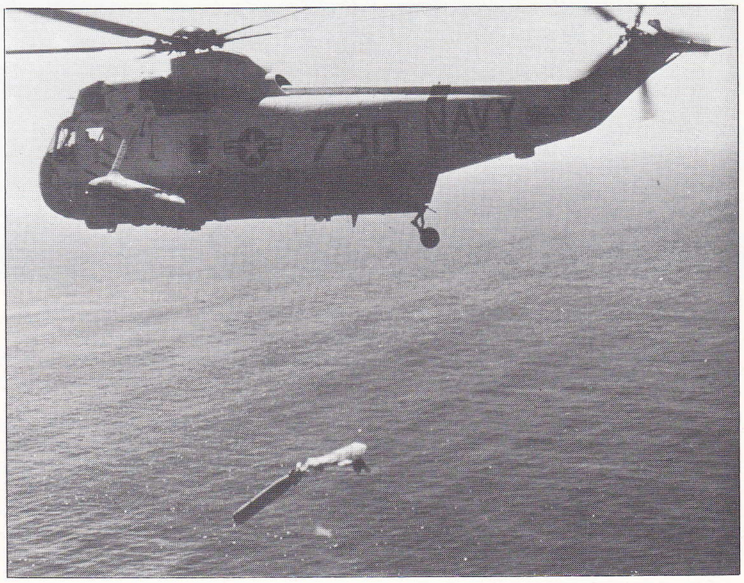
Specification
Mk 44
Dimensions: diameter 324 mm (12.75 in); length (Mod 0) 2.54 m (8.33 ft) or (Mod 1) 2.57 m (8.44 ft)
Weight: (Mod 0) 192.8 kg (425 lb) or (Mod 1) 196.4 kg (433 lb)
Warhead: (Mod 0) 34-kg (75-lb) HE or (Mod 1) 33.1-kg (73-lb) HE
Performance: speed 30 kts; range 5.5 km (3.4 miles)

Specification
Mk 46
Dimensions: diameter 324 mm (12.75 in); length 2.6 m (8.5 ft)
Weight: (Mod 0) 257.6 kg (568 lb) or (Mod 1, 2, 4 and 5) 230.4 kg (508 lb)
Warhead: 43.1-kg (95-lb) HE
Performance: speed 40/45 kts; range 11 km (6.8 miles) at 15-m (50-ft) depth or 5.5 km (3.4 miles) at 457-m (1,500-ft) depth

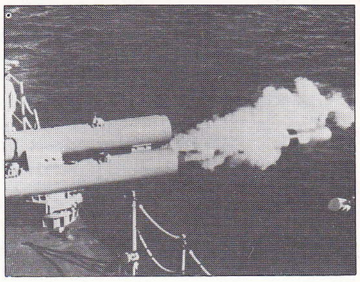
Specification (provisional)
Mk 50 Barracuda
Dimensions: diameter 324 mm (12.75 in); length 2.9 m (9.5 ft)
Weight: 362.9 kg (800 lb)
Warhead: 45.4-kg (100-lb) shaped-charge HE
Performance: speed 55+ kts; range 13.7 km (8.5 miles)



More than 9,000 Mk 46 lightweight torpedoes have been produced by Honeywell for service with the US Navy and the naval forces of more than 20 other countries. It is launched from the air, the surface and by ASROC.



Above: The development of the dedicated anti-submarine helicopter, together with the lightweight acoustic homing torpedo, has immensely extended ASW radius. This Mk 46 torpedo, dropped by an SH-3A Sea King, is deploying a parachute to retard its speed.

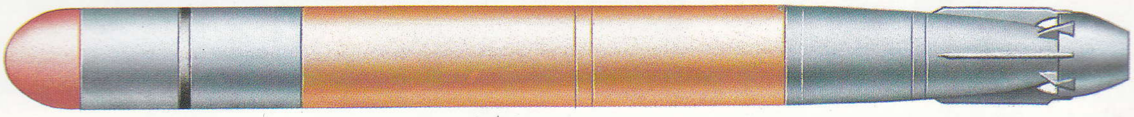


Right: A Mk 46 torpedo is launched from one of the triple torpedo tubes fitted to all of the cruisers, destroyers and frigates of the US Navy.

The Israeli navy is one of several that have acquired Mk 46 torpedoes, and some of the 36 'Dabur' class coastal patrol craft operating in the Mediterranen and the Red Sea have been equipped with a pair of single tubes.

USA

Mk 48 torpedo



The Mk 48 torpedo is carried by all US attack and ballistic missile submarines, a continual process of development having enhanced its performance in line with that of Soviet submarines in the past 15 years.

The **Mk 48** heavyweight torpedo is the latest in a long line of US Navy 533-mm (21-in) calibre submarine-launched weapons. As a long-range selectable-speed wire-guided dual-role (ASW/anti-ship) weapon it replaced both the Mk 37 series wire-guided ASW torpedo and the US Navy's only nuclear-armed torpedo, the anti-ship Mk 45 ASTOR fitted with a 10-kiloton yield W34 warhead. Development of the Mk 48 began in 1957 when feasibility studies were initiated to meet an operational requirement eventually issued in late 1960. The weapon was intended as both a surface- and submarine-launched torpedo, but the former requirement was dropped when surface-launched weapons went out of favour. Two versions were produced to meet the range and speed performance figures needed to engage a 35-kt submerged target: the **Westinghouse Mk 48 Mod 0**, which used a gas turbine and was subsequently refined to the proposed production **Mk 48 Mod 2** variant, and the **Gould Mk 48 Mod 1** which used an Otto-fuelled piston (swashplate) engine and a redesigned acoustic-homing system. The latter was chosen for mass production, operational capability being achieved in 1972.

The next version to be built was the **Mk 48 Mod 3**, which had the same 762-m (2,500-ft) depth capability as the Mod 1 but introduced a new two-way TELECOM (rather than one-way) wire-guidance communication link that allowed the torpedo head to transmit its search data back to the launch platform for more accurate processing to produce what was in effect a track-via-torpedo guidance mode.

The latest production standard (to which most previous weapons are being upgraded) is the **Mk 48 Mod 4**. This has the same TELECOM facilities of the Mod 3, enhanced speed (to 55 kts) and depth (to 915 m/3,000 ft) capabilities, plus an additional fire-and-forget mode which can be initiated if the torpedo's own noise masks the launch submarine's passive sonar detection sets.

By 1978, because of an increasing awareness of the latest Soviet submarine capabilities in the area of speed and diving depth, an **ADvanced CAPability (ADCAP)** version of the Mk 48, the **Mk 48 Mod 5**, entered development. A new higher-powered sonar was fitted both to improve the target acquisition range from the current 3660 m (12,000 ft) and to reduce the effect of enemy decoys and anechoic coatings. The sonar is electrically steered to decrease the need for the torpedo to manoeuvre in the search phase. Together with a larger fuel load, this gives the new variant a longer range (using the same propulsion system) and a new under-ice capability. Further modifications are at present being researched to give an **Upgraded ADCAP** weapon for the next decade: these developments include improved anti-ship homing features, an even greater maximum diving depth and a higher target speed engagement envelope. The operational date for the first ADCAP Mk 48 Mod 5 is expected to be 1986. Foreign users of the Mk 48 are limited to Australia and the Netherlands.

Specification

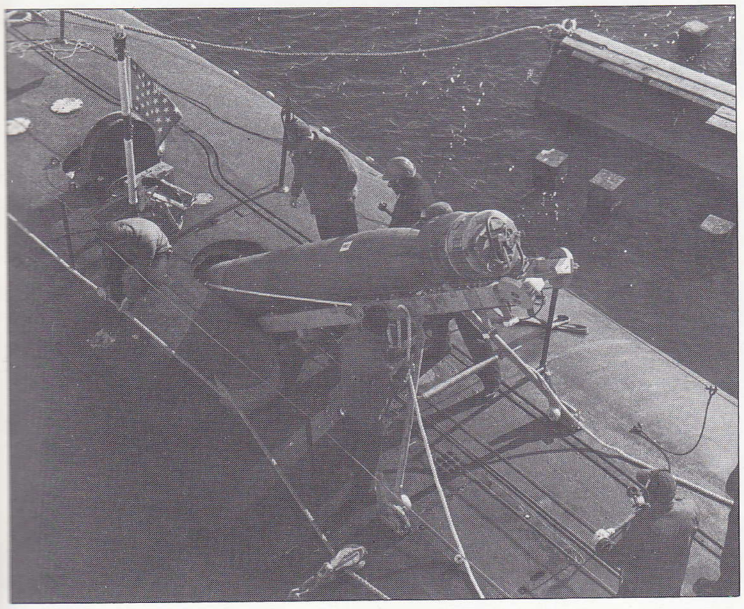
Mk 48

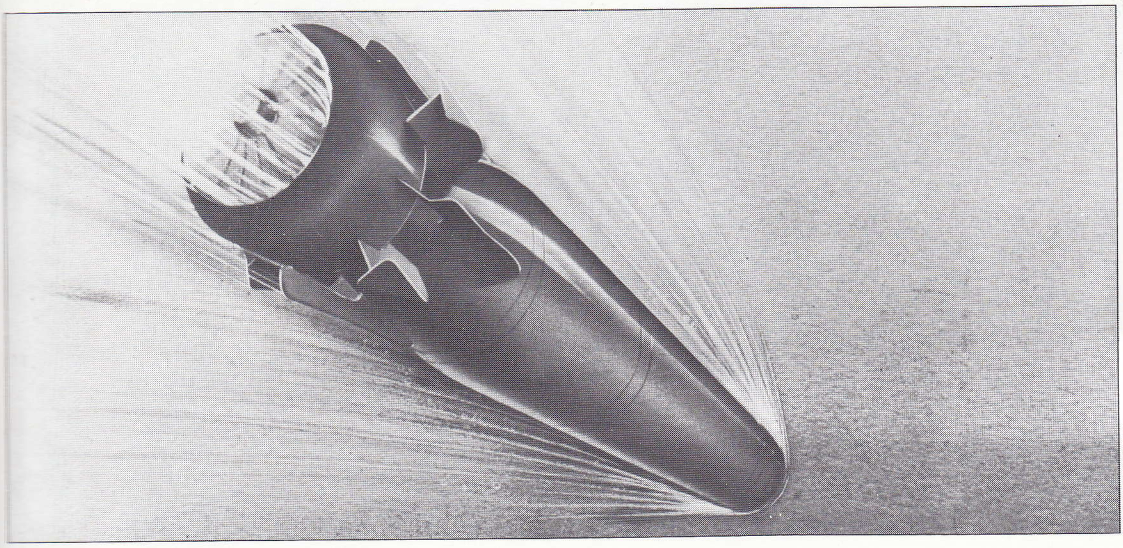
Dimensions: diameter 533 mm (21 in); length 5.8 m (19.17 ft)

Weight: 1579 kg (3,480 lb)

Warhead: 294.5-kg (650-lb) HE

Performance: speed (Mod 1 and 3) 48 kts, (Mod 4) 55 kts or (Mod 5) 60 kts; range (Mod 1 and 3) 32 km (20 miles), (Mod 4) 28 km (17.5 miles) or (Mod 5) 38 km (23.75 miles)





Above: Crewmen aboard the 'Sturgeon' class nuclear attack submarine USS Pargo *carefully receive a Mk 48 Mod 1 torpedo into the torpedo room. Most current American SSNs have reduced torpedo armament to allow for missiles such as Subroc, Harpoon and Tomahawk, or tube-launched mines.*

Above left: A Mk 48 torpedo is lowered into the torpedo room of the nuclear-powered ballistic missile submarine USS Stonewall Jackson *at the Naval Submarine Support base at Kings Bay, Georgia. These submarines are armed with torpedoes for self-protection only.*

Left: An artist's impression of the last stage in the life of a Mk 48, with the onboard sonar homing in on the hapless target at a maximum speed of close to 60 kts.

ITALY

Whitehead Motofides A184 and A244 torpedoes

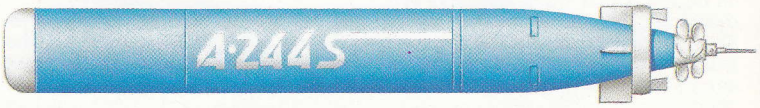
The **A184** is a dual-purpose ASW/anti-ship heavyweight wire-guided torpedo produced by Whitehead Motofides and carried by Italian navy submarines and surface ships. It has also been exported to Taiwan for use on its 'Guppy II' and 'Improved Zwaardvis' class submarines. The panoramic active/passive acoustic-homing head controls the torpedo's course and depth in the final attack phase whilst the initial wire guidance uses the launch platform's own sonar sensors to guide the weapon up to the point of acoustic acquisition. Like most modern electrically-powered torpedoes the A184 is fitted with a silver-zinc battery and has dual speed capabilities (low speed for the passive hunting phase and high speed for the terminal attack or active phase).

To complement the A184 and replace the American Mk 44 for operations in the notoriously difficult ASW environment of the Mediterranean the lightweight **A244** was developed. This is an electrically-driven weapon suitable for use by aircraft, helicopters or surface ships in normal or shallow waters. In its original form it was fitted with a Selenia AG70 homing head, but the latest variant, the **A244/S**, has a CIACIO-S advanced homing seeker. Using special signal-processing technique, this allows both active and passive operations which can discriminate between a real target and decoys. The A244 and A244/S have been sold to a number of countries including Argentina, Ecuador, India, Indonesia, Iraq, Libya, Nigeria, Peru and Venezuela. Whitehead is currently working on a replacement weapon for the A244 series, the 50-kt high-performance **A290**, which uses seeker technology derived from the A244/S weapon.

Capable of submarine or surface launch, the Whitehead A184 is capable of engaging both submarine and surface targets. Wire-guided, it is capable of operating at great depths and in a two-speed mode.

Specification
A184
Dimensions: diameter 533 mm (21 in); length 6.00 m (19.69 ft)
Weight: 1265 kg (2,789 ;b)
Warhead: 250-kg (551-lb) HE
Performance: 24 or 36 kts; range 25 or 10 km (15.53 or 6.21 miles)

Specification
A244/S
Dimensions: diameter 324 mm (12.75 in); length 2.70 m (8.86 ft)
Weight: 221 kg (487 lb)
Warhead: 34-kg (75-lb) HE
Performance: speed 30 kts; range 6.5 km (4.04 miles)



The Mediterranean is a very difficult environment for the effective use of torpedoes, and the A244 has been designed to replace the US-built Mk 44 in Italian service with that fact in mind.

Right: Designed for launch from surface ships, helicopters and aircraft, the A244 is capable of both active and passive operations, in a wide variety of attack patterns. The weapon has also been adapted as a potential warload for the Ikara anti-submarine missile system.

Below: The A184 is the latest heavyweight product of one of the world's oldest torpedo manufacturers. As with most modern torpedoes, it is electrically powered to a maximum speed of 36 kts, and has a maximum range of 10 km (6.21 miles) at that speed.

A·184
Whitehead

Mexico

Although the Mexican armed forces played a critical role in national politics up to and including the revolution of 1911-20, they are now the least political in Latin America and are responsible for little more than internal security. Defence against external enemies has generally been left to Mexico's powerful northern neighbour, the USA.

Mexico is divided into 35 Military Zones, which correspond basically with the 31 States of Mexico and the solitary Federal District. As in the other countries in the region, all three services are engaged in various forms of civic action that include public health and educational programmes.

The army

The 94,500-strong Mexican army garrisons each of the Military Zones with one or two infantry battalions and, in the majority of them, one cavalry regiment. Based at Mexico City itself are the main army units, including the mechanized battalions of the Presidential Guard brigade group, two infantry brigade groups and one paratroop brigade. The cavalry regiments are gradually undergoing mechanization with both wheeled AFVs and soft-skinned vehicles as these are purchased. A full list of the army units currently in being includes:

one infantry division HQ,
one Presidential Guard mechanized brigade group (of three battalions),
two infantry brigade groups (each of two infantry battalions, one armoured reconnaissance squadron and one artillery battalion),
one paratroop brigade (of two battalions),
64 independent infantry battalions,
one special forces battalion,
one armoured regiment,
one armoured reconnaissance regiment,
28 independent cavalry regiments,
three artillery regiments,
one combat engineer battalion,
19 construction battalions,
unknown number of independent engineer companies, and
unknown number of independent air-defence artillery batteries.

Armoured cars confront students during the 1968 riots. The Mexican army has had little hand in national politics (by Latin American standards) since 1929, but the refusal of the PRI to concede so much as a single election in 1985 might well bring the political struggle on to the streets before long.

To back these regular units there are an additional 250,000 conscripts who are organized into National Service Brigades that receive minimal military training.

The equipment used by the army is a curious mixture of fairly modern European and obsolete American types; several models of AFVs have been exported only to Mexico. A small indigenous armaments industry exists, and this manufactures a few types of small arms, ammunition and more recently an indigenously designed light armoured car known as the DN-3 Caballo. The most recent foreign purchases have included 42 French Panhard ERC-90F1 Lynx armoured cars and 27 Panhard VBL light reconnaissance vehicles (including eight equipped to carry and fire Milan ATGWs). A full list of the equipment in service is:

Operated by Escuadron Aero 209, Grupo Aereo 1, based at Santa Lucia, Mexico State, this Aérospatiale SA 330J Puma is one of two VIP transport helicopters operated by the Mexican air force.

SA 330 J
F-WMHH
TPH-0
PELIGRO

12 Pass

armour: M3A1 Stuart and M5A1 Stuart light tanks; DN-3 Caballo, M3A1 and Panhard VBL scout cars; MAC-1, Panhard ERC-90F1 and M8 armoured cars; and HWK-11, M3A1, Panhard M3VTS, MOWAG Roland and AMX-10P APCs;
artillery: (towed) 75-mm (2.95-in) M116 pack howitzers and 105-mm (4.13-in) M101 howitzers; (self-propelled) 75-mm M8 and 105-mm M7 howitzers;
(mortars) 60-mm (2.36-in) US, 81-mm (3.2-in) French and US, 107-mm (4.2-in) US and 120-mm (4.72-in) French;
anti-armour weapons: 3.5-in (88.9-mm) M20 rocket-launchers, 57-mm M18 recoilless rifles, 37-mm M3 ATG and Milan ATGWs;
air-defence weapons: 12.7-mm M55 gun; and
small arms: 0.45-in (11.43-mm) Obregon and Colt M1911 pistols; 0.3-in (7.62-mm) M1 Garand, M2 Carbine and HK33 rifles; 5.56-mm (0.219-in) HK53 and 0.45-in M1928A1 Thompson SMGs; 0.3-in Browning Automatic Rifle and RM2 LMGs; 0.3-in Browning M1919 MMG; and 0.5-in Browning HMG.

The navy

The 15,200-man Mexican navy has 13 Naval Zones to protect, of which five are subordinated to the Gulf of Mexico Command and eight to the Pacific Ocean Command. A small 350-man naval air arm flies three squadrons and operates a small training school. Of the squadrons the most important are the maritime patrol squadron with eight Grumman HU-16A Albatross amphibians, and the helicopter squadron with four Aérospatiale Alouette IIIs, five Bell 47Gs and five MBB BO 105s. The last are configured for shipboard use.

The 4,500-strong marine corps is organized into three battalion headquarters that control a total of 19 Marine security companies. They are equipped with obsolete small arms and French 81-mm mortars.

Although the discovery of oil in Mexico allowed more money for the defence budget, with many re-equipment schemes being proposed, the subsequent economic crises have now delayed indefinitely any real chance of their implementation, and the navy has had to maintain in service its fleet of old surface combatants. The navy's role appears to be the patrolling of an exclusive economic zone (including the offshore oilfields) and fishery protection against foreign poachers. In 1982 two ex-US Navy 'Gearing' class FRAM-1 destroyers of World War II vintage were bought. The only other major purchases in recent times have been the six 'Halcon' class patrol ships ordered from Spain in 1982 and the continuing programme of the 'Azteca' class large patrol craft, initially from the UK and then from local shipyards after 1973. In a recent expansion of the local shipbuilding capability nine 'Aquila' class patrol ships have been ordered. These are basically a version of the 'Halcon' class modified to local needs. The complete inventory of the navy includes:

destroyers: two ex-US 'Gearing FRAM-1' class and one ex-US 'Fletcher' class;
frigates: one ex-US 'Edsall' class, one 'Durango' class and four 'Charles Lawrence/Crosley' class;
light forces: six 'Halcon' class large patrol craft, nine 'Aquila' class large patrol craft (building), 18 ex-US 'Auk' class patrol ships, 16 ex-US 'Admirable' class patrol ships, one 'Guanajuato' class patrol craft, 31 'Azteca' class large patrol craft (plus more building), seven coastal patrol craft, and 17 river patrol craft;
amphibious warfare forces: two LSTs; and
support ships: seven survey ships, one tender, one transport, two harbour tankers, one training ship, eight tugs and 13 miscellaneous vessels.

The air force

Like the other two services, the Mexican air force has suffered considerably from financial restraints and it was not until 1981, with the delivery of a single squadron of 10 Northrop F-5E and two F-5F Tiger II fighters, that it re-entered the arena of air forces operating jet fighters. The Tigers operate alongside a single counter-insurgency (COIN) squadron flying 14 Lockheed AT-33A armed jet trainers. The considerable force of North American AT-28D armed piston-engined trainers has now been retired, the six COIN squadrons now flying armed and camouflaged Pilatus PC-7 Turbo Trainers. A total of 55 has been procured for both the COIN and basic training roles. A photo-reconnaissance/survey squadron also exists, and this uses some eight Rockwell Aero Commander 500s equipped with cameras. For the SAR mission there are two squadrons, of which one doubles in the light tactical support role with eight IAI Arava 201 transports; the other operates 23 helicopters of eight different makes, of which numerically the most important are the five Bell 206B JetRangers and 10 Bell 205As which can also be armed for the COIN role.

The fixed-wing transport needs of the armed forces and civilian government departments are undertaken by four squadrons and a VIP presidential unit. The latter has a mixed inventory of nine Boeing 727 jetliners, two Boeing 737 jetliners, a Fokker F.27, a Lockheed JetStar VIP jet, Lockheed Electra airliner, a BAe HS125-400 VIP jet, five Rockwell Sabreliner commuter jets and a Cessna 410R, plus a single Bell 212 and two Aérospatiale SA 330 Puma VIP helicopters. The remaining fixed-wing transport assets include two Douglas DC-6s, one Douglas DC-7, five Douglas C-54s, 20 Douglas C-47s, three de Havilland Canada DHC-5D Buffaloes, 12 Pilatus-Britten Norman Islanders, three Shorts Skyvans, five Fokker F.27 Friendships and a few Cessna twin-engine light communications aircraft.

Training for the various squadrons is undertaken on 20 Mudry CAP-10B primary trainers. The trainee pilots then progress onto the survivors of 20 Beech F33C and 20 Beech Musketeer Sport trainers before they finally attempt the Pilatus PC-7. Multi-engined training is done on a few Beech Barons and Piper Aztecs, while helicopter pilots learn the Bell 47G at squadron level.

For rapid-reaction duties the air force operates a paratroop battalion that is independent of the army.

Paramilitary forces

Mexican paramilitary forces comprise 23,400 Federal Police and a 120,000-strong Rural Defence Corps. The latter includes some 80,000 mounted personnel and 40,000 dismounted members, all using obsolete small arms passed down from the armed forces.

There is also a small coast guard which has six patrol craft and an aviation element with 17 helicopters and fixed-wing aircraft. The coast guard is currently involved heavily with its American counterpart on anti-smuggling duties to prevent drugs reaching the USA.

Organized intrusions into Mexican fishing grounds, plus the need to protect the offshore oil fields, have increased the importance of the country's navy in recent years. **Heriberto Jara Corona** ***is one of 31 'Azteca' class large patrol boats armed with one 40-mm (1.57-in) and one 20-mm (0.78-in) gun.***